Empirical Analysis of Digital Literacy Differences Among E-Commerce Teachers in Universities

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Abstract: With the rapid advancement of digital technology, enhancing educators' digital literacy is crucial for improving teaching effectiveness, especially in e-commerce education. Age, years of teaching experience, teacher's title, and educational background all influence e-commerce teachers' digital literacy in higher education. Through using the methods of single-factor difference analysis, analyzing data from surveys to evaluate their disparities, this study finds that digital proficiency differs based on varying age and teaching experiences; younger (26-35 year olds) and those with little experience (0-5 years) have better digital skills than those who are older or more experienced in teaching positions. Teachers with junior college diplomas are generally superior in their utilization of profession-related resources and digital resources compared to those holding higher degrees; assistant professors also scored highest in overall digital literacy levels within corresponding titles. These findings provide insight into existing gaps in the degree which allows for digital competence development in educators can be advanced through focused efforts by educational administrators.

Keywords: Digital Literacy, E-Commerce Teachers, Higher Education, Univariate Analysis

1. Introduction

This study adopts the EU Digital Literacy Framework for Educators (DigCompEdu) due to its comprehensive evaluation of digital competence across six key areas: professional participation (Zy), digital resources (Sz), teaching and learning (Jy), assessment (Pg), empowering learners (Sq), and promoting learners' digital competence (Cj). The framework effectively supports e-commerce teachers in digital teaching and is widely recognized for its practicality[1]. This study analyzes the impact of age, gender, professional title, and teaching experience on these six dimensions of digital literacy.

1.1 Problem Statement

By using Single Factor Difference Analysis to investigate how age, years of teaching, professional title and teaching experience affect the digital literacy of e-commerce teachers in universities[2]. Collecting statistical data from questionnaire surveys about disparity effects between groups determined by the determinant factors, aiming at revealing gaps exist already between different demographic groups.

1.2 Research Purpose

The purpose of the paper is to analyze the effect of variables associated with some individuals' personal features like age, length of time worked in a profession (teaching experience), rank of the person concerned (academic title) and seniority as regards level of education attained etc.[3], concerning digital literacy among online commerce major teachers from Universities throughout Guangdong Province.

2. Research Methods

2.1 Reliability and Validity Analysis

Solidly researched information is crucial for any effort, before performing reliability test and examining the authenticity of results via reliability analysis and confirm the extent to which they accurately reflect actual digital literacies and practical instructional activities conducted by instructors through administering the questionnaire survey, Cronbach Alpha method has been adopted to calculate internal reliability of survey questionnaires, Alpha > 0

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suggests fairly reliable tests/observations/ measurements/assessment result reported. We examined whether the questions in our test correlate highly enough internally in order to form coherent factors via exploratory factor analysis (EFA).

2.2 Univariate Analysis

The author tries to identify these factors with univariate difference analysis and examine how they impact teachers' digital literacy. ANOVA: Analysis of Variance is the main test used for univariate difference analysis in the research. This approach utilizes Analysis of Variance (ANOVA) to identify significant discrepancies in total scores on digital literacy achieved by teachers categorized into different groups[4].Subsequently, the data were subjected to analysis in SPSS statistical software.

3. Univariate Analysis of Digital Literacy Differences among E-Commerce Teachers in Universities

To analyze different situations of the development of digital literacy in e-commerce majors' teachers from various backgrounds. Then try to find related factors through univariate difference analysis, and examine its influence on teachers' digital literacy. Univariate: The statistical tests for univariate difference are ANOVA/Analysis of Variance. In this paper, it applies Analysis of Variance when comparing the total marks on digital literacy obtained by the team divided into different types. Identify significant variation first. Use SPSS to operate data.

3.1 Questionnaire Distribution and Collection

Through the above methods, a total of 591 questionnaires were distributed, 582 were collected, and 566 were valid, resulting in an effective response rate of 90% (*e.g.*, Table 1). The efficient collection of questionnaires not only reflects the teachers' support and recognition of this study but also demonstrates the effectiveness of the online questionnaire distribution method. The research team will conduct an in-depth analysis of the collected data to provide a scientific basis and practical guidance for improving the digital literacy of e-commerce teachers.

Table 1. Statistics of Questionnaire Distribution and Collection

Questionnaire items	Number of questionnaires distributed	Number of returned questionnaires	Number of valid questionnaires	Recovery rate	Efficiency
Teacher Questionnaire	591	582	566	98.5%	97.3%

3.2 Reliability and Validity Analysis

The reliability analysis results indicate that the Cronbach's alpha coefficients for all dimensions of the digital literacy scale for e-commerce teachers range between 0.811 and 0.902, with an overall questionnaire reliability of 0.982. This suggests strong internal consistency and high reliability of the measurement tool. Regarding validity, the KMO values for each dimension exceed 0.6, and the overall KMO value reaches 0.967, demonstrating the adequacy of the sample for factor analysis. Additionally, Bartlett's test of sphericity is significant ($p < 0.001$) across all dimensions, confirming that the questionnaire items are suitable for factor analysis and possess strong construct validity.

3.3 Single Factor Difference Analysis

This section will compare the results of the survey on the digital literacy of college e-commerce teachers across various factors such as age, teaching experience, education level, and professional title to draw additional conclusions. The author employs one-way analysis of variance (ANOVA) to examine the differences between these factors.

3.3.1 One-way ANOVA of different ages

(1) Professional participation

The data reveal significant age differences in the digital literacy of college e-commerce teachers. Teachers aged 26-35 scored the highest across all dimensions (3.62-3.96) (*e.g.*, Table 2), particularly in digital collaborative innovative teaching (Zy4, 3.96±1.04). Middle-aged teachers (36-55 years old) scored lower (2.0-2.4), highlighting their challenges in adapting to digital teaching. Although teachers over 55 years old had lower overall scores, they performed slightly better than the 46-55 age group in certain areas (*e.g.*, Zy3, 2.18±1.02), suggesting that some senior teachers are actively adapting. It is recommended that

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colleges and universities implement a cross-age digital mentoring system to facilitate the exchange and transfer of digital skills between generations.

Table 2. One-Way ANOVA of Different Ages in the Professional Participation Dimension

	Your age: (mean ± standard deviation)				F	p
	26-35 years old (n=136)	36-45 years old (n=185)	46-55 years old (n=115)	55 years and above (n=130)		
Zy1	3.86±1.04	2.17±1.03	2.07±0.86	2.22±0.98	102.418	0.000**
Zy2	3.85±0.97	2.23±0.95	2.08±0.80	2.25±1.03	106.007	0.000**
Zy3	3.77±1.03	2.12±1.05	1.91±0.83	2.18±1.02	100.819	0.000**
Zy4	3.96±1.04	2.01±0.95	1.94±0.86	2.06±1.01	139.617	0.000**
Zy5	3.62±0.97	2.39±0.91	2.17±0.79	2.32±1.01	70.077	0.000**
* p<0.05 ** p<0.01						

(2) Digital resources

Table 3. One-Way ANOVA of Different Ages in Digital Resource Dimensions

	Your age: (mean ± standard deviation)				F	p
	26-35 years old (n=136)	36-45 years old (n=185)	46-55 years old (n=115)	55 years and above (n=130)		
Sz1	3.79±0.98	2.42±0.95	2.14±0.86	2.27±1.00	86.748	0.000**
Sz2	3.66±0.98	2.00±0.94	1.97±0.79	2.00±0.96	111.531	0.000**
Sz3	3.95±0.98	2.14±0.93	2.06±0.81	2.10±0.99	134.854	0.000**
Sz4	3.79±1.02	2.16±1.02	1.97±0.90	2.16±1.03	97.906	0.000**
Sz5	3.85±1.04	1.97±0.86	2.02±0.76	2.14±0.93	140.134	0.000**
Sz6	3.79±1.05	2.03±1.06	1.68±0.82	2.08±1.02	118.962	0.000**
* p<0.05 ** p<0.01						

There are significant age differences in the digital resource literacy of college e-commerce teachers ($p < 0.01$) (*e.g.*, Table 3). Teachers aged 26-35 performed the best across all dimensions, with average scores ranging from 3.66 to 3.95, particularly excelling in modifying and creating digital resources (Sz3, 3.95±0.98). Middle-aged and older teachers (over 36 years old) generally scored lower (1.97-2.42), reflecting difficulties in adapting to new technologies. The greatest difference in ability was seen in organizing and sharing digital resources (Sz5, F=140.134), with the 26-35 age group significantly outperforming other groups. In terms of privacy and copyright awareness, the 46-55 age group scored the lowest (Sz6, 1.68±0.82). The ability to select and evaluate resources also declined with age, with the 26-35 age group (3.66±0.98) far surpassing the others (around 2.00). Overall, young teachers performed well in all aspects of digital resource management, while middle-aged and older teachers faced greater challenges.

(3) Teaching and learning

According to data analysis, there are significant age differences in the digital literacy of e-commerce teachers in universities, specifically in the areas of teaching and learning. Teachers aged 26-35 performed the best across all eight dimensions (Jy1-Jy8) (*e.g.*, Table 4), with average scores ranging from 3.44 to 3.95, significantly higher than other age groups. In particular, they excelled in providing digital guidance (Jy4, 3.95±0.93) and managing digital teaching interventions (Jy2, 3.86±1.01). In contrast, teachers aged 36-45, 46-55, and over 55 generally scored lower across most dimensions, with scores ranging from 1.74 to 2.44. Notably, the 46-55 age group had the lowest score in promoting learners' autonomous learning (Jy8, 1.74±0.77). However, teachers over 55 performed slightly better than the 46-55 age group in some aspects (such as Jy4, 2.44±0.96), suggesting that some senior teachers are actively adapting to digital teaching.

This significant age difference ($p<0.000$ for all dimensions) highlights the strengths of younger teachers in digital teaching, but also emphasizes the need for targeted digital skills training for middle-aged and older teachers to enhance overall teaching quality and effectiveness.

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Table 4. One-Way ANOVA of Different Ages in Teaching and Learning Dimensions

	Your age: (mean ± standard deviation)				F	p
	26-35 years old (n=136)	36-45 years old (n=185)	46-55 years old (n=115)	55 years and above (n=130)		
Jy1	3.80±0.98	2.17±0.94	1.93±0.79	2.24±1.01	111.923	0.000**
Jy2	3.86±1.01	1.94±1.00	2.04±0.85	2.15±1.01	122.147	0.000**
Jy3	3.48±1.00	2.15±0.85	2.03±0.82	2.12±0.95	78.730	0.000**
Jy4	3.95±0.93	2.14±1.01	1.99±0.81	2.44±0.96	124.998	0.000**
Jy5	3.80±0.97	2.18±0.97	1.83±0.80	2.08±0.99	120.296	0.000**
Jy6	3.76±0.96	2.08±0.85	2.30±0.82	2.26±1.04	102.654	0.000**
Jy7	3.81±1.03	2.17±1.01	2.07±0.80	2.31±0.96	99.204	0.000**
Jy8	3.44±0.89	2.02±0.91	1.74±0.77	2.00±0.89	103.873	0.000**
* p<0.05 ** p<0.01						

(4) Teaching assessment

Table 5. One-Way ANOVA of Different Ages in Teaching Assessment Dimensions

	Your age: (mean ± standard deviation)				F	p
	26-35 years old (n=136)	36-45 years old (n=185)	46-55 years old (n=115)	55 years and above (n=130)		
Pg1	3.99±1.00	2.25±0.95	2.03±0.83	2.25±0.93	128.125	0.000**
Pg2	3.52±0.95	2.04±1.03	1.86±0.83	2.01±1.02	87.900	0.000**
Pg3	3.71±0.97	2.22±0.94	2.22±0.77	2.22±0.98	88.887	0.000**
Pg4	3.79±1.01	2.12±0.99	1.92±0.85	2.08±1.06	107.892	0.000**
Pg5	3.95±1.03	2.05±0.97	1.88±0.81	2.22±0.87	144.668	0.000**
Pg6	3.68±0.93	2.14±1.01	2.03±0.85	2.12±1.03	91.858	0.000**
* p<0.05 ** p<0.01						

The analysis results reveal significant age differences in the digital literacy of Teaching Assessment among college e-commerce teachers (all dimensions $p < 0.01$) (*e.g.*, Table 5). The 26-35-year-old teacher group performed the best across all six dimensions (Pg1-Pg6), with average scores ranging from 3.52 to 3.99. Notably, they excelled in using digital technology for evaluation (Pg1, 3.99±1.00) and providing feedback (Pg5, 3.95±1.03).

In contrast, teachers aged 36 and above generally scored lower across all dimensions (1.86-2.25). Specifically, the 46-55-year-old group scored the lowest in enhancing assessment diversity (Pg2) and analyzing digital evidence (Pg4), with scores of 1.86±0.83 and 1.92±0.85, respectively. The most significant age differences were observed in providing digital feedback (Pg5, F=144.668), where the 26-35-year-old group (3.95±1.03) far outperformed the other groups. Teachers over 55 (2.22±0.87) scored slightly better than the middle-aged group.

Overall, young teachers excel in all aspects of digital teaching assessment, while middle-aged and older teachers face greater challenges in adapting to and applying digital assessment technologies. Targeted training and support are necessary to help these groups improve their digital assessment skills.

(5) Empowering learners

The analysis results indicate significant age differences in the ability of e-commerce teachers in universities to empower learners' digital literacy (all dimensions $p < 0.01$) (*e.g.*, Table 6). The 26-35-year-old teacher group performed the best across all six dimensions (Sq1-Sq6), with average scores ranging from 3.64 to 3.97. They particularly excelled in ensuring the accessibility of learning resources (Sq1, 3.97±1.04) and cultivating students' active participation (Sq5, 3.92±1.08).

In contrast, teachers aged 36 and above scored lower across all dimensions (1.85-2.24). The 46-55-year-old group scored the lowest in implementing differentiated and personalized teaching (Sq4, 1.85±0.84). The most significant age differences were observed in ensuring the accessibility of learning resources (Sq1,

F=125.196), with the 26-35-year-old group (3.97±1.04) significantly outperforming the other groups. There were also notable differences in considering learners' numerical expectations and abilities (Sq2, F=106.489).

Overall, young teachers excel in using digital technology to empower learners, while middle-aged and older teachers face greater challenges in this area. Strengthening relevant training and support is crucial to improving the digital literacy of middle-aged and older teachers in empowering learners.

Table 6. One-Way ANOVA of Different Ages in Empowered Learners

	Your age: (mean ± standard deviation)				F	p
	26-35 years old (n=136)	36-45 years old (n=185)	46-55 years old (n=115)	55 years and above (n=130)		
Sq1	3.97±1.04	2.23±0.92	2.17±0.79	2.24±0.90	125.196	0.000**
Sq2	3.64±0.93	2.02±0.93	1.95±0.84	2.03±1.00	106.489	0.000**
Sq3	3.72±1.04	2.16±0.97	2.14±0.79	2.19±0.96	92.203	0.000**
Sq4	3.77±0.98	2.08±0.98	1.85±0.84	2.20±0.92	118.047	0.000**
Sq5	3.92±1.08	2.16±0.89	2.08±0.82	2.16±1.02	120.596	0.000**
Sq6	3.68±0.90	2.12±1.03	2.10±0.81	2.19±1.06	88.205	0.000**
* p<0.05 ** p<0.01						

(6) Promoting learners' digital capabilities

Table 7. One-Way ANOVA of Different Ages in Promoting Learners' Digital Competence Dimensions

	Your age: (mean ± standard deviation)				F	p
	26-35 years old (n=136)	36-45 years old (n=185)	46-55 years old (n=115)	55 years and above (n=130)		
Cj1	3.77±1.03	2.18±0.92	2.05±0.85	2.19±1.04	99.195	0.000**
Cj2	3.77±0.97	2.12±0.94	2.03±0.85	2.11±0.96	111.642	0.000**
Cj3	3.96±0.99	1.99±1.03	2.10±0.85	2.12±1.02	128.285	0.000**
Cj4	3.66±0.94	2.25±0.92	2.09±0.82	2.19±0.99	88.945	0.000**
Cj5	3.78±0.96	2.27±0.82	2.03±0.80	2.27±0.90	115.318	0.000**
Cj6	3.77±1.00	2.08±1.01	2.04±0.84	2.31±1.06	95.935	0.000**
Cj7	3.90±1.01	2.15±0.90	2.01±0.79	2.18±0.90	133.010	0.000**
Cj8	3.71±0.97	2.13±0.97	2.01±0.83	2.05±1.00	101.280	0.000**
Cj9	3.85±1.00	2.03±0.99	1.88±0.84	2.16±1.03	122.882	0.000**
* p<0.05 ** p<0.01						

According to data analysis, there are significant differences in various digital abilities (Cj1-Cj9) among learners of different ages (p<0.05) (*e.g.*, Table 7). The 26-35 age group scored the highest in all dimensions, with an average score ranging from 3.66 to 3.96, significantly higher than other age groups. For example, in expressing and evaluating information needs (Cj1), the 26-35 age group had an average score of 3.77±1.03, while the 36-45 age group scored 2.18±0.92, the 46-55 age group scored 2.05±0.85, and the 55+ age group scored 2.19±1.04 (F=99.195, p=0.000).

In contrast, learners aged 36-45, 46-55, and over 55 generally scored lower in most dimensions, with scores ranging between 1.88 and 2.27. The 46-55 age group, in particular, scored the lowest in digital problem-solving ability (Cj9, 1.88±0.84). However, the over 55 group scored slightly higher than the middle-aged group in some aspects (such as Cj5, 2.27±0.90), suggesting that some senior learners are actively adapting to the digital environment.

This significant age difference highlights the strengths of younger learners in digital capabilities and underscores the need for targeted digital skills training for middle-aged and older learners to improve overall learning outcomes.

3.3.2 One-way ANOVA of teaching experience

(1) Professional participation

According to data analysis, there were significant differences in professional engagement (Zy1-Zy5) among teachers with different teaching experiences (*p*<0.05) (*e.g.*, Table 8). The 0-5 years group performed best in all dimensions, with average scores ranging

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from 3.80 to 3.97, significantly higher than other groups. For instance, in using digital technology to enhance communication (Zy1), the 0-5 years group had an average score of 3.95±1.07, while the 6-10 years group scored 3.33±1.26, the 11-15 years group scored 2.18±0.81, the 16-20 years group scored 2.01±0.87, and the group with more than 20 years of experience scored 2.07±1.01 (F=69.438, *p*=0.000).

In contrast, teachers with 11-15 years, 16-20 years, and more than 20 years of experience generally scored lower in most dimensions, with scores ranging from 1.89 to 2.35. Notably, the 11-15 years group scored the lowest in collaborative development and improvement of organizational communication pathways (Zy2, 1.89±0.81). However, the group with over 20 years of experience performed slightly better than the middle-aged groups in some areas (such as Zy5, 2.35±0.98), suggesting that some senior teachers are actively adapting to digital teaching.

This significant difference in experience highlights the advantages of new teachers in professional engagement while also emphasizing the need for targeted digital skills training for middle-aged and older teachers to improve overall teaching quality and effectiveness.

Table 8. One-Way ANOVA of Teaching Experience in the Dimension of Professional Participation

	Your teaching experience: (mean ± standard deviation)					F	p
	0-5 years (n=65)	6-10 years (n=120)	11-15 years (n=141)	16-20 years (n=116)	More than 20 years (n=124)		
Zy1	3.95±1.07	3.33±1.26	2.18±0.81	2.01±0.87	2.07±1.01	69.438	0.000**
Zy2	3.92±1.05	3.33±1.16	1.89±0.81	2.21±0.75	2.34±1.00	75.062	0.000**
Zy3	3.80±1.06	3.14±1.37	1.96±0.87	1.97±0.85	2.27±1.02	54.890	0.000**
Zy4	3.89±1.03	3.34±1.36	1.95±0.84	1.90±0.85	2.03±1.02	75.602	0.000**
Zy5	3.97±1.02	3.02±1.09	2.17±0.77	2.28±0.77	2.35±0.98	55.394	0.000**
* p<0.05 ** p<0.01							

(2) Digital resources

Table 9. One-Way ANOVA of Teaching Experience in the Digital Resource Dimension

	Your teaching experience: (mean ± standard deviation)					F	p
	0-5 years (n=65)	6-10 years (n=120)	11-15 years (n=141)	16-20 years (n=116)	More than 20 years (n=124)		
Sz1	3.92±0.96	3.30±1.17	2.30±0.78	2.09±0.86	2.31±1.03	59.732	0.000**
Sz2	3.72±0.99	3.13±1.19	1.86±0.80	1.92±0.78	2.04±0.99	71.646	0.000**
Sz3	3.77±1.03	3.42±1.33	1.94±0.81	2.09±0.81	2.19±0.97	70.132	0.000**
Sz4	3.94±1.06	3.32±1.10	1.94±0.89	1.97±0.85	2.14±1.06	78.334	0.000**
Sz5	3.85±1.03	3.21±1.30	1.91±0.77	1.99±0.79	2.13±0.92	72.664	0.000**
Sz6	3.69±1.04	3.23±1.41	1.81±0.88	1.82±0.88	2.10±1.05	63.702	0.000**
* p<0.05 ** p<0.01							

According to data analysis, there were significant differences in the ability to use digital resources (Sz1-Sz6) among teachers with different teaching experiences (*p*<0.05) (*e.g.*, Table 9). The 0-5 years group performed best in all dimensions, with average scores ranging from 3.69 to 3.94, significantly higher than other groups. For example, in considering learning goals and context when selecting digital resources (Sz1), the average score of the 0-5 years group was 3.92±0.96, while the 6-10 years group scored 3.30±1.17, the 11-15 years group scored 2.30±0.78, the 16-20 years group scored 2.09±0.86, and the group with over 20 years of experience scored 2.31±1.03 (F=59.732, *p*=0.000).

In contrast, teachers with 11-15 years, 16-20 years, and more than 20 years of experience scored lower in most dimensions, generally between 1.81 and 2.35. Notably, the 11-15 years group scored the lowest in identifying and selecting digital resources suitable for teaching (Sz2, 1.86±0.80). However, the group with over 20 years of experience performed slightly better than the middle-aged group in some aspects (such as Sz6, 2.10±1.05),

indicating that some senior teachers are actively adapting to digital teaching.

This significant difference in experience highlights the advantages of new teachers in using digital resources, while also emphasizing the need for targeted digital skills training for middle-aged and older teachers to enhance the overall quality and effectiveness of teaching.

(3) Teaching and learning

Table 10. One-Way ANOVA of Teaching Experience in the Teaching and Learning Dimension

	Your teaching experience: (mean ± standard deviation)					F	p
	0-5 years (n=65)	6-10 years (n=120)	11-15 years (n=141)	16-20 years (n=116)	More than 20 years (n=124)		
Jy1	3.83±1.04	3.32±1.20	2.01±0.78	2.02±0.78	2.15±1.01	72.626	0.000**
Jy2	3.85±1.00	3.32±1.27	1.81±0.80	1.95±0.86	2.17±1.06	76.974	0.000**
Jy3	3.54±1.00	2.98±1.12	1.97±0.78	2.03±0.78	2.24±0.98	48.430	0.000**
Jy4	4.05±0.94	3.33±1.29	2.04±0.80	2.13±0.82	2.27±1.01	72.803	0.000**
Jy5	3.78±0.89	3.20±1.36	1.90±0.86	1.96±0.83	2.24±0.96	64.350	0.000**
Jy6	3.80±1.03	3.23±1.08	2.10±0.80	2.16±0.83	2.22±1.06	58.791	0.000**
Jy7	3.91±1.13	3.22±1.28	2.16±0.82	2.09±0.82	2.18±0.95	58.886	0.000**
Jy8	3.48±0.83	2.97±1.14	1.79±0.75	1.82±0.78	2.07±0.94	65.547	0.000**
* p<0.05 ** p<0.01							

According to data analysis, there were significant differences in the teaching and learning dimensions (Jy1-Jy8) among teachers with different teaching experiences (*p*<0.05) (*e.g.*, Table 10). The 0-5 years group performed best in all dimensions, with average scores ranging from 3.48 to 4.05, significantly higher than other groups. For example, in terms of planning and implementing digital devices and resources to improve the effectiveness of teaching interventions (Jy1), the average score of the 0-5 years group was 3.83±1.04, while the 6-10 years group scored 3.32±1.20, the 11-15 years group scored 2.01±0.78, the 16-20 years group scored 2.02±0.78, and the group with more than 20 years of experience scored 2.15±1.01 (F=72.626, *p*=0.000).

In contrast, teachers with 11-15 years, 16-20 years, and more than 20 years of experience scored lower in most dimensions, generally ranging from 1.79 to 2.24. Notably, the 11-15 years group scored the lowest in managing and arranging digital teaching interventions (Jy2, 1.81±0.80). However, the group with more than 20 years of experience performed slightly better than the middle-aged group in some aspects (such as Jy3, 2.24±0.98), indicating that some senior teachers are actively adapting to digital teaching.

This significant difference in experience underscores the advantages of new teachers in using digital technology, while also emphasizing the need for targeted digital skills training for middle-aged and older teachers to improve the overall quality and effectiveness of teaching.

(4) Teaching assessment

According to data analysis, there are significant differences in the Teaching Assessment dimensions (Pg1-Pg6) among teachers with different teaching experiences (*p*<0.05) (*e.g.*, Table 11). The 0-5 years group performed best in all dimensions, with average scores ranging from 3.69 to 4.02, significantly higher than other groups. For example, in the use of digital technology for formative and summative assessment (Pg1), the average score of the 0-5 years group was 4.02±0.94, while the 6-10 years group scored 3.37±1.35, the 11-15 years group scored 2.01±0.81, the 16-20 years group scored 2.16±0.79, and the group with more than 20 years of experience scored 2.31±0.93 (F=73.005, *p*=0.000).

Table 11. One-Way ANOVA of Teaching Experience in Evaluation Dimensions

	Your teaching experience: (mean ± standard deviation)					F	p
	0-5 years (n=65)	6-10 years (n=120)	11-15 years (n=141)	16-20 years (n=116)	More than 20 years (n=124)		
Pg1	4.02±0.94	3.37±1.35	2.01±0.81	2.16±0.79	2.31±0.93	73.005	0.000**
Pg2	3.69±0.98	3.05±1.14	1.88±0.82	1.82±0.83	2.02±1.03	68.461	0.000**

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Pg3	3.74±1.03	3.23±1.16	2.18±0.82	2.02±0.81	2.31±0.92	57.097	0.000**
Pg4	3.89±1.05	3.24±1.20	2.00±0.82	1.91±0.85	2.05±1.08	73.168	0.000**
Pg5	3.94±1.01	3.36±1.33	1.96±0.79	1.93±0.80	2.10±0.94	82.500	0.000**
Pg6	3.89±0.97	3.18±1.05	1.99±0.86	2.04±0.86	2.05±1.06	72.800	0.000**
* p<0.05 ** p<0.01							

In contrast, teachers with 11-15 years, 16-20 years, and more than 20 years of experience scored lower in most dimensions, generally ranging from 1.88 to 2.31. Notably, the 11-15 years group scored the lowest in using digital technology to enhance the diversity of assessment formats and methods (Pg2, 1.88±0.82). However, the group with more than 20 years of experience performed slightly better than the middle-aged group in some aspects (such as Pg3, 2.31±0.92), indicating that some senior teachers are actively adapting to digital teaching assessment.

This significant difference in experience highlights the advantages of new teachers in using digital technology, but also underscores the need for targeted digital skills training for middle-aged and older teachers to enhance the overall quality and effectiveness of teaching.

(5) Empowering learners

Table 12. One-Way ANOVA of Teaching Experience in the Dimension of Empowering Learners

	Your teaching experience: (mean ± standard deviation)					F	p
	0-5 years (n=65)	6-10 years (n=120)	11-15 years (n=141)	16-20 years (n=116)	More than 20 years (n=124)		
Sq1	4.00±1.12	3.40±1.23	2.13±0.78	2.07±0.81	2.30±0.88	75.712	0.000**
Sq2	3.52±0.94	3.21±1.17	1.95±0.81	1.92±0.83	1.98±1.05	63.384	0.000**
Sq3	3.80±1.08	3.20±1.23	2.06±0.78	2.14±0.82	2.15±0.97	59.162	0.000**
Sq4	3.80±0.99	3.23±1.28	1.96±0.80	1.87±0.81	2.17±0.95	72.432	0.000**
Sq5	3.80±1.03	3.40±1.29	2.04±0.83	1.95±0.83	2.28±0.99	68.495	0.000**
Sq6	3.69±0.90	3.25±1.16	2.08±0.85	2.07±0.81	2.08±1.12	58.955	0.000**
* p<0.05 ** p<0.01							

There were significant differences in the dimensions of empowering learners (Sq1-Sq6) among teachers with different teaching experiences (*p*<0.05) (*e.g.*, Table 12). The 0-5 years group performed best in all dimensions, with average scores ranging from 3.52 to 4.00, significantly higher than other groups. For example, in terms of ensuring that all learners, including those with special needs, have access to learning resources and activities (Sq1), the average score of the 0-5 years group was 4.00±1.12, while the 6-10 years group scored 3.40±1.23, the 11-15 years group scored 2.13±0.78, the 16-20 years group scored 2.07±0.81, and the group with more than 20 years of experience scored 2.30±0.88 (F=75.712, *p*=0.000).

Additionally, teachers with 11-15 years, 16-20 years, and more than 20 years of experience scored lower in most dimensions, generally ranging from 1.95 to 2.30. Notably, the 11-15 years group scored the lowest in considering and responding to learners' expectations, abilities, and contexts for using digital technology (Sq2, 1.95±0.81). However, the group with more than 20 years of experience performed slightly better than the middle-aged group in some aspects (such as Sq3, 2.15±0.97), indicating that some senior teachers are actively adapting to digital teaching.

This significant difference in experience highlights the advantages of new teachers in the use of digital technology, but also emphasizes the need for targeted digital skills training for middle-aged and older teachers to improve the overall quality and effectiveness of teaching.

(6) Promoting learners' digital capabilities

Table 13. One-Way ANOVA of Teaching Experience in Promoting Learners' Digital Competence

	Your teaching experience: (mean ± standard deviation)					F	p
	0-5 years (n=65)	6-10 years (n=120)	11-15 years (n=141)	16-20 years (n=116)	More than 20 years (n=124)		
Cj1	3.65±1.02	3.40±1.19	2.06±0.79	2.05±0.82	2.13±1.07	64.782	0.000**

Cj2	3.83±1.01	3.24±1.13	1.97±0.84	1.91±0.86	2.22±0.95	74.124	0.000**
Cj3	3.94±1.04	3.31±1.36	1.89±0.86	2.08±0.88	2.13±1.03	69.372	0.000**
Cj4	3.80±0.94	3.19±1.05	2.10±0.81	2.03±0.83	2.24±0.99	65.321	0.000**
Cj5	3.72±0.94	3.23±1.23	2.21±0.75	2.08±0.78	2.26±0.91	56.966	0.000**
Cj6	3.95±1.05	3.17±1.18	1.94±0.81	1.99±0.89	2.35±1.08	66.556	0.000**
Cj7	3.88±0.96	3.36±1.28	2.00±0.78	2.03±0.75	2.19±0.90	78.947	0.000**
Cj8	3.75±1.02	3.18±1.16	2.00±0.81	1.85±0.90	2.20±1.00	66.220	0.000**
Cj9	3.83±1.01	3.23±1.35	1.88±0.87	2.01±0.83	2.11±1.03	65.554	0.000**
* p<0.05 ** p<0.01							

According to data analysis, teachers with different teaching experiences showed significant differences in promoting learners' digital competence dimensions (Cj1-Cj9) (*p*<0.05) (*e.g.*, Table 13). The 0-5 years group performed best in all dimensions, with average scores ranging from 3.65 to 3.95, significantly higher than the other groups. For example, in terms of clearly expressing information needs and evaluating the credibility of information sources (Cj1), the average score of the 0-5 years group was 3.65±1.02, while the 6-10 years group scored 3.40±1.19, the 11-15 years group scored 2.06±0.79, the 16-20 years group scored 2.05±0.82, and the group with more than 20 years of experience scored 2.13±1.07 (F=64.782, *p*=0.000).

Furthermore, teachers with 11-15 years, 16-20 years, and more than 20 years of experience scored lower in most dimensions, generally ranging from 1.88 to 2.35. Notably, the 11-15 years group scored the lowest in cultivating students' information and media literacy (Cj2, 1.97±0.84). However, the group with more than 20 years of experience performed slightly better than the middle-aged group in some aspects (such as Cj6, 2.35±1.08), indicating that some senior teachers are actively adapting to digital teaching.

This significant difference in experience highlights the advantages of new teachers in the use of digital technology but also underscores the need for targeted digital skills training for middle-aged and older teachers to improve the overall quality and effectiveness of teaching.

3.3.3 One-way ANOVA of educational level

(1) Professional participation

Table 14. One-Way ANOVA of Education Level in the Professional Participation Dimension

	Your education level: (mean ± standard deviation)				F	p
	Specialty (n=18)	Undergraduate(n=98)	Master's degree(n=314)	PhD(n=136)		
Zy1	3.00±1.33	2.62±1.18	2.61±1.22	2.38±1.23	2.077	0.102
Zy2	3.33±1.46	2.62±1.10	2.59±1.20	2.49±1.12	2.797	0.040*
Zy3	3.00±1.57	2.31±1.23	2.54±1.21	2.44±1.22	2.003	0.112
Zy4	3.00±1.19	2.66±1.30	2.41±1.29	2.41±1.22	2.086	0.101
Zy5	3.61±1.33	2.49±1.09	2.68±1.11	2.46±0.92	7.035	0.000**
* p<0.05 ** p<0.01						

According to data analysis, there were significant differences in professional engagement dimensions (Zy1-Zy5) among teachers with different educational levels (*p*<0.05) (*e.g.*, Table 14). The college group performed best in some dimensions. For example, in terms of making important contributions to the collaborative development and improvement of organizational communication pathways (Zy2), the average score of the college group was 3.33±1.46, while that of the undergraduate group was 2.62±1.10, the master's group scored 2.59±1.20, and the doctoral group scored 2.49±1.12 (F=2.797, *p*=0.040).

Additionally, the junior college group scored the highest in reflecting and developing digital teaching practices (Zy5, 3.61±1.33), significantly higher than the other groups. The master's degree group also scored higher in this dimension (2.68±1.11) compared to the doctoral degree group (2.46±0.92), indicating that teachers with a master's degree had a higher degree of participation in this aspect.

However, there were no significant differences between teachers with different educational

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levels in terms of using digital technologies to enhance communication (Zy1), collaborating with other educators (Zy3), and innovating teaching practices through digital collaboration (Zy4) (*p*>0.05).

These results show that teachers with a college degree or master's degree are more active in some dimensions of professional engagement, while teachers with a doctoral degree are relatively less engaged in these aspects. This highlights the need for targeted improvement in professional engagement at different educational levels.

(2) Digital resources

Table 15. One-Way ANOVA of Educational Level in the Digital Resource Dimension

	Your education level: (mean ± standard deviation)				F	p
	Specialty (n=18)	Undergraduate(n=98)	Master's degree(n=314)	PhD(n=136)		
Sz1	3.33±1.37	2.56±1.22	2.65±1.13	2.65±1.10	2.319	0.074
Sz2	2.89±1.41	2.50±1.16	2.39±1.19	2.27±1.08	1.854	0.136
Sz3	3.22±1.26	2.49±1.15	2.53±1.27	2.54±1.13	1.940	0.122
Sz4	3.50±1.15	2.65±1.18	2.49±1.22	2.32±1.25	5.514	0.001**
Sz5	2.94±1.26	2.36±1.26	2.52±1.18	2.39±1.16	1.609	0.186
Sz6	3.17±1.38	2.36±1.24	2.44±1.28	2.19±1.28	3.537	0.015*
* p<0.05 ** p<0.01						

According to data analysis, there were significant differences in the digital resource dimensions (Sz1-Sz6) among teachers with different educational levels (*p*<0.05) (*e.g.*, Table 15). The specialist group performed best in some dimensions. For example, in terms of taking into account specific learning objectives, contexts, teaching methods, and learner groups when designing digital resources and planning their use (Sz4), the average score of the specialist group was 3.50±1.15, while that of the undergraduate group was 2.65±1.18, the master's group was 2.49±1.22, and the doctoral group was 2.32±1.25 (F=5.514, *p*=0.001).

Additionally, the specialist group scored the highest in taking effective measures to protect sensitive digital content and comply with privacy and copyright rules (Sz6, 3.17±1.38), which was significantly higher than other groups. However, there were no significant differences (*p*>0.05) between teachers with different educational levels in selecting digital resources and planning their use (Sz1), identifying and selecting digital resources suitable for teaching and learning (Sz2), modifying and building on existing openly licensed resources (Sz3), and effectively organizing digital content (Sz5).

These results show that teachers with a college degree are more active in some aspects of digital resource management and use, while teachers with other educational levels are relatively less involved in these areas. This highlights the need for targeted improvements in teachers' digital resource management capabilities across different educational levels.

(3) Teaching and learning

According to data analysis, there were significant differences in the teaching and learning dimensions (Jy1-Jy8) among teachers with different educational levels (*p*<0.05) (*e.g.*, Table 16). The specialist group performed best in multiple dimensions. For example, in terms of planning and implementing digital devices and resources to improve the effectiveness of teaching interventions during teaching (Jy1), the average score of the specialist group was 3.61±1.14, while that of the undergraduate group was 2.54±1.24, the master's group was 2.48±1.15, and the doctoral group was 2.50±1.15 (F=5.367, *p*=0.001).

Table 16. One-Way ANOVA of Educational Attainment in the Teaching and Learning Dimension

	Your education level: (mean ± standard deviation)				F	p
	Specialty (n=18)	Undergraduate(n=98)	Master's degree(n=314)	PhD(n=136)		
Jy1	3.61±1.14	2.54±1.24	2.48±1.15	2.50±1.15	5.367	0.001**
Jy2	3.17±1.34	2.43±1.22	2.52±1.26	2.29±1.22	3.083	0.027*
Jy3	3.22±1.52	2.49±0.99	2.42±1.07	2.35±1.06	3.670	0.012*
Jy4	3.50±1.04	2.51±1.26	2.61±1.19	2.57±1.22	3.563	0.014*

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Jy5	2.94±1.26	2.52±1.09	2.48±1.23	2.38±1.22	1.271	0.284
Jy6	3.44±1.38	2.37±1.22	2.61±1.09	2.52±1.10	4.849	0.002**
Jy7	3.17±0.99	2.76±1.25	2.53±1.14	2.47±1.24	2.771	0.041*
Jy8	2.89±1.32	2.21±1.00	2.31±1.10	2.26±1.08	2.020	0.110
* p<0.05 ** p<0.01						

In addition, the specialist group scored the highest in managing and arranging digital teaching interventions (Jy2, 3.17±1.34) and using digital technology to enhance interaction with learners (Jy3, 3.22±1.52), which was significantly higher than other groups. The master's group also scored higher in these dimensions than the doctoral group, indicating that teachers with a master's degree have a higher degree of participation in these aspects.

However, there were no significant differences between teachers of different educational levels in terms of using digital technologies to foster and enhance learners' collaboration (Jy5) and to enable learners to plan, monitor, and reflect on their own learning (Jy8) (*p*>0.05).

These results show that teachers with a college degree are more active in some aspects of teaching and learning, while teachers with other educational levels are relatively less engaged in these areas. This highlights the need to improve teachers' teaching and learning abilities in a targeted manner at different educational levels.

(4) Teaching assessment

Table 17. One-Way ANOVA of Educational Level in Evaluation Dimensions

	Your education level: (mean ± standard deviation)				F	p
	Specialty (n=18)	Undergraduate(n=98)	Master's degree(n=314)	PhD(n=136)		
Pg1	3.22±1.06	2.49±1.23	2.67±1.22	2.54±1.17	2.205	0.087
Pg2	3.00±1.41	2.48±1.22	2.27±1.16	2.38±1.10	2.819	0.038*
Pg3	3.17±1.29	2.42±1.13	2.63±1.12	2.49±1.08	2.884	0.035*
Pg4	3.39±1.24	2.58±1.27	2.43±1.24	2.38±1.14	4.082	0.007**
Pg5	2.78±1.35	2.58±1.34	2.48±1.20	2.49±1.24	0.468	0.705
Pg6	3.28±1.18	2.61±1.10	2.46±1.23	2.36±1.07	3.729	0.011*
* p<0.05 ** p<0.01						

According to data analysis, there were significant differences (*p*<0.05) in the Teaching Assessment dimensions (Pg1-Pg6) among teachers with different educational levels (*e.g.*, Table 17). The specialist group performed best in multiple dimensions. For example, in terms of using digital technology to enhance the diversity and applicability of evaluation formats and methods (Pg2), the average score of the specialist group was 3.00±1.41, while that of the master's group was 2.27±1.16 and that of the doctoral group was 2.38±1.10 (F=2.819, *p*=0.038).

In addition, the specialist group scored the highest in generating, selecting, critically analyzing, and interpreting digital evidence about learners' activities, performance, and progress (Pg3, 3.17±1.29) and analyzing digital evidence to improve teaching (Pg4, 3.39±1.24), which was significantly higher than other groups. The master's group also scored higher than the doctoral group in these dimensions, indicating that teachers with a master's degree have a higher degree of participation in these aspects.

However, there were no significant differences among teachers of different educational levels in terms of using digital technologies for formative and summative assessment (Pg1) and providing targeted and timely feedback to learners (Pg5) (*p*>0.05).

These results show that teachers with a college degree are more active in some aspects of Teaching Assessment, while teachers with other educational levels are relatively less involved in these areas. This highlights the need to improve teachers' Teaching Assessment capabilities in a targeted manner at different educational levels.

(5) Empowering learners

According to data analysis, teachers with different educational levels showed significant differences in the dimensions of empowering learners (Sq1-Sq6) (*p*<0.05) (*e.g.*, Table 18). The college group performed best in some dimensions. For example, in terms of

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effectively using digital technology in teaching pathways to cultivate learners' transversal skills, deep thinking, and creative expression (Sq6), the average score of the college group was 3.56±1.20, while that of the undergraduate group was 2.51±1.13, that of the master's group was 2.47±1.14, and that of the doctoral group was 2.46±1.20 (F=5.107, *p*=0.002).

However, there were no significant differences (*p*>0.05) between teachers with different educational levels in ensuring that all learners, including those with special needs, have access to learning resources and activities (Sq1), considering and responding to learners' expectations and abilities (Sq2), using digital technologies to meet learners' different learning needs (Sq3), implementing differentiated and personalized teaching (Sq4), and fostering learners' active and creative engagement with the subject matter (Sq5).

These results show that teachers with a college degree are more active in some aspects of empowering learners, while teachers with other educational levels are relatively less engaged in these aspects. This highlights the need to improve teachers' ability to empower learners in a targeted manner at different educational levels.

Table 18. One-Way ANOVA of Educational Level in the Empowered Learner Dimension

	Your education level: (mean ± standard deviation)				F	p
	Specialty (n=18)	Undergraduate(n=98)	Master's degree(n=314)	PhD(n=136)		
Sq1	3.00±1.24	2.60±1.16	2.66±1.21	2.57±1.14	0.801	0.494
Sq2	3.00±1.41	2.44±1.29	2.39±1.09	2.31±1.17	1.932	0.123
Sq3	3.22±1.31	2.62±1.12	2.51±1.15	2.45±1.19	2.614	0.050
Sq4	3.00±1.08	2.57±1.24	2.43±1.20	2.41±1.14	1.646	0.178
Sq5	3.06±1.47	2.61±1.19	2.55±1.24	2.51±1.14	1.145	0.330
Sq6	3.56±1.20	2.51±1.13	2.47±1.14	2.46±1.20	5.107	0.002**
* p<0.05 ** p<0.01						

(6) Promoting learners' digital capabilities

According to data analysis, teachers with different educational levels showed significant differences in promoting learners' digital competence dimensions (Cj1-Cj9) (*p*<0.05) (*e.g.*, Table 19). The specialist group performed best in multiple dimensions. For example, in terms of incorporating learning activities, assignments, and assessments that require learners to clearly express their information needs and find information and resources in a digital environment (Cj1), the average score of the specialist group was 3.67±1.03, while that of the undergraduate group was 2.60±1.18, that of the master's group was 2.48±1.18, and that of the doctoral group was 2.49±1.15 (F=6.079, *p*=0.000).

In addition, the specialist group scored the highest in teaching learners about copyright and licenses applicable to digital content (Cj6, 3.72±1.13) and improving learners' digital problem-solving skills (Cj9, 3.28±1.32), which was significantly higher than other groups. The master's group also scored higher than the doctoral group in these dimensions, indicating that teachers with a master's degree have a higher degree of participation in these aspects.

However, there were no significant differences (*p*>0.05) between teachers with different educational levels in terms of developing students' information and media literacy (Cj2), using digital technologies to communicate and collaborate (Cj3), expressing themselves through digital means (Cj5), empowering learners to manage risks (Cj7), and identifying and solving technological problems (Cj8).

Table 19. One-Way ANOVA of Educational Level in Promoting Learners' Digital Competence

	Your education level: (mean ± standard deviation)				F	p
	Specialty (n=18)	Undergraduate(n=98)	Master's degree(n=314)	PhD(n=136)		
Cj1	3.67±1.03	2.60±1.18	2.48±1.18	2.49±1.15	6.079	0.000**
Cj2	2.94±1.21	2.51±1.10	2.50±1.22	2.43±1.12	1.036	0.376
Cj3	3.17±1.38	2.56±1.30	2.46±1.29	2.51±1.19	1.781	0.150
Cj4	3.28±1.27	2.52±1.15	2.55±1.10	2.44±1.07	3.035	0.029*
Cj5	3.06±1.26	2.54±1.02	2.61±1.11	2.50±1.11	1.455	0.226
Cj6	3.72±1.13	2.58±1.27	2.46±1.17	2.50±1.20	6.411	0.000**

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Cj7	3.00±1.19	2.61±1.21	2.53±1.19	2.50±1.14	1.089	0.353
Cj8	3.00±1.41	2.56±1.13	2.47±1.18	2.31±1.16	2.266	0.080
Cj9	3.28±1.32	2.43±1.17	2.38±1.26	2.59±1.22	3.525	0.015*
* p<0.05 ** p<0.01						

These results show that teachers with a college degree are more active in promoting learners' digital capabilities, while teachers with other educational levels are relatively less involved in these aspects. This highlights the need to improve teachers' digital capabilities at different educational levels in a targeted manner.

3.3.4 One-way ANOVA of different job titles

(1) Professional participation

Table 20. One-Way ANOVA of Different Professional Titles in the Professional Participation Dimension

	Your job title: (mean ± standard deviation)					F	p
	Professor (n=39)	Associate Professor (n=158)	Lecturer (n=257)	Teaching assistant (n=110)	Others (n=2)		
Zy1	1.92±0.87	2.23±0.96	2.40±1.16	3.70±1.15	1.50±0.71	39.067	0.000**
Zy2	2.10±0.85	2.16±1.00	2.50±1.08	3.62±1.14	1.50±0.71	35.744	0.000**
Zy3	1.92±0.84	2.18±0.99	2.38±1.23	3.40±1.24	2.00±0.00	23.463	0.000**
Zy4	1.92±0.77	2.01±0.97	2.33±1.17	3.69±1.30	2.00±0.00	42.705	0.000**
Zy5	2.03±0.81	2.36±0.95	2.54±1.00	3.41±1.15	2.00±0.00	23.448	0.000**
* p<0.05 ** p<0.01							

According to data analysis, there are significant differences in professional engagement dimensions (Zy1-Zy5) among teachers of different titles (*p*<0.05) (*e.g.*, Table 20). The teaching assistant group performed best in multiple dimensions. For example, in terms of using digital technology to strengthen organizational communication with learners, parents, and third parties (Zy1), the average score of the teaching assistant group was 3.70±1.15, while that of the professor group was 1.92±0.87, that of the associate professor group was 2.23±0.96, and that of the lecturer group was 2.40±1.16 (F=39.067, *p*=0.000).

In addition, the teaching assistant group scored the highest in collaborative development and improvement of organizational communication pathways (Zy2, 3.62±1.14) and in the use of digital technology to collaborate with other educators (Zy3, 3.40±1.24), which was significantly higher than other groups. The lecturer group also scored higher than the professor group and the associate professor group in these dimensions, indicating that lecturers and teaching assistants were more involved in these aspects.

These results show that teaching assistants and lecturers are more active in professional engagement, while professors and associate professors are relatively less engaged in these aspects. This highlights the need to improve the professional engagement of teachers at different levels of professional titles.

(2) Digital resources

According to data analysis, there were significant differences in the digital resource dimensions (Sz1-Sz6) among teachers of different titles (*p*<0.05) (*e.g.*, Table 21). The teaching assistant group performed best in multiple dimensions. For example, in terms of considering specific learning goals, contexts, teaching methods, and learner groups when selecting digital resources and planning their use (Sz1), the average score of the teaching assistant group was 3.64±1.02, while that of the professor group was 2.18±0.85, that of the associate professor group was 2.30±1.00, and that of the lecturer group was 2.54±1.10 (F=32.097, *p*=0.000).

Table 21. One-Way ANOVA of Different Job Titles in Digital Resource Dimension

	Your job title: (mean ± standard deviation)					F	p
	Professor (n=39)	Associate Professor (n=158)	Lecturer (n=257)	Teaching assistant (n=110)	Others (n=2)		
Sz1	2.18±0.85	2.30±1.00	2.54±1.10	3.64±1.02	2.00±0.00	32.097	0.000**
Sz2	1.72±0.79	1.99±0.93	2.33±1.15	3.37±1.05	2.50±0.71	34.011	0.000**

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Sz3	2.08±0.77	2.16±0.95	2.46±1.17	3.50±1.32	2.00±1.41	26.887	0.000**
Sz4	1.74±0.88	2.16±0.99	2.32±1.15	3.75±0.99	1.50±0.71	49.715	0.000**
Sz5	2.05±0.83	2.09±0.89	2.31±1.11	3.56±1.23	1.50±0.71	37.468	0.000**
Sz6	1.62±0.81	2.11±1.01	2.26±1.22	3.39±1.38	1.50±0.71	27.401	0.000**
* p<0.05 ** p<0.01							

In addition, the teaching assistant group scored the highest in identifying, evaluating, and selecting digital resources suitable for teaching and learning (Sz2, 3.37±1.05) and modifying and building existing open-licensed resources (Sz3, 3.50±1.32), which was significantly higher than other groups. The lecturer group also scored higher than the professor group and the associate professor group in these dimensions, indicating that lecturers and teaching assistants were more involved in these aspects.

These results show that teaching assistants and lecturers are more active in the use and management of digital resources, while professors and associate professors are relatively less involved in these aspects. This highlights the need to improve the digital resource management capabilities of teachers at different levels of professional titles.

(3) Teaching and learning

Table 22. One-Way ANOVA of Different Titles in Teaching and Learning Dimensions

	Your job title: (mean ± standard deviation)					F	p
	Professor (n=39)	Associate Professor (n=158)	Lecturer (n=257)	Teaching assistant (n=110)	Others (n=2)		
Jy1	1.92±0.87	2.11±0.95	2.39±1.08	3.70±1.05	2.00±0.00	47.173	0.000**
Jy2	2.03±0.84	2.09±1.02	2.35±1.23	3.49±1.19	1.00±0.00	29.451	0.000**
Jy3	2.05±0.65	2.13±0.97	2.35±1.03	3.25±1.06	1.00±0.00	25.217	0.000**
Jy4	2.15±0.87	2.23±0.94	2.42±1.16	3.78±1.07	2.00±0.00	42.039	0.000**
Jy5	1.74±0.85	2.09±0.94	2.41±1.15	3.47±1.22	1.50±0.71	33.011	0.000**
Jy6	2.18±0.79	2.27±0.98	2.40±1.10	3.54±1.05	2.00±0.00	30.356	0.000**
Jy7	2.18±0.88	2.16±0.94	2.47±1.15	3.57±1.15	1.50±0.71	31.791	0.000**
Jy8	1.90±0.75	1.96±0.88	2.17±1.03	3.25±1.07	1.50±0.71	33.834	0.000**
* p<0.05 ** p<0.01							

According to data analysis, there were significant differences in the teaching and learning dimensions (Jy1-Jy8) among teachers of different titles (*p*<0.05) (*e.g.*, Table 22). The teaching assistant group performed best in multiple dimensions. For example, in terms of planning and implementing digital devices and resources to improve the effectiveness of teaching interventions during teaching (Jy1), the average score of the teaching assistant group was 3.70±1.05, while that of the professor group was 1.92±0.87, that of the associate professor group was 2.11±0.95, and that of the lecturer group was 2.39±1.08 (F=47.173, *p*=0.000).

In addition, the teaching assistant group scored the highest in managing and arranging digital teaching interventions (Jy2, 3.49±1.19) and using digital technology to enhance interaction with learners (Jy3, 3.25±1.06), which was significantly higher than other groups. The lecturer group also scored higher in these dimensions than the professor group and the associate professor group, indicating that lecturers and teaching assistants were more involved in these aspects.

These results show that teaching assistants and lecturers are more active in teaching and learning, while professors and associate professors are relatively less involved in these aspects. This highlights the need to improve the teaching and learning capabilities of teachers at different professional levels in a targeted manner.

(4) Teaching assessment

Table 23. One-Way ANOVA of Different Job Titles in Evaluation Dimensions

	Your job title: (mean ± standard deviation)					F	p
	Professor (n=39)	Associate Professor (n=158)	Lecturer (n=257)	Teaching assistant (n=110)	Others (n=2)		

Pg1	2.08±0.74	2.22±0.95	2.52±1.13	3.66±1.27	2.00±1.41	33.825	0.000**
Pg2	1.74±0.85	1.99±0.97	2.26±1.17	3.31±1.00	2.00±1.41	30.430	0.000**
Pg3	2.18±0.79	2.33±0.91	2.39±1.07	3.53±1.11	1.00±0.00	31.091	0.000**
Pg4	1.92±0.90	1.99±1.01	2.44±1.18	3.45±1.17	2.00±0.00	31.259	0.000**
Pg5	2.10±0.85	1.99±0.92	2.39±1.14	3.69±1.24	2.00±0.00	44.044	0.000**
Pg6	1.82±0.82	2.15±0.97	2.35±1.15	3.53±1.00	2.00±0.00	35.824	0.000**
* p<0.05 ** p<0.01							

According to data analysis, there were significant differences (*p*<0.05) in the Teaching Assessment dimensions (Pg1-Pg6) among teachers of different titles (*e.g.*, Table 23). The teaching assistant group performed best in multiple dimensions. For example, in terms of using digital technology for formative and summative evaluation (Pg1), the average score of the teaching assistant group was 3.66±1.27, while that of the professor group was 2.08±0.74, that of the associate professor group was 2.22±0.95, and that of the lecturer group was 2.52±1.13 (F=33.825, *p*=0.000).

In addition, the teaching assistant group scored the highest in the use of digital technology to enhance the diversity and applicability of assessment formats and methods (Pg2, 3.31±1.00) and the generation, selection, critical analysis, and interpretation of digital evidence about learners' activities, performance, and progress (Pg3, 3.53±1.11), which was significantly higher than other groups. The lecturer group also scored higher than the professor group and the associate professor group in these dimensions, indicating that lecturers and teaching assistants were more involved in these aspects.

These results show that teaching assistants and lecturers are more active in Teaching Assessment, while professors and associate professors are relatively less engaged in these aspects. This highlights the need to improve the Teaching Assessment capabilities of teachers at different professional title levels.

(5) Empowering learners

According to data analysis, there were significant differences in the dimensions of empowering learners (Sq1-Sq6) among teachers of different titles (*p*<0.05) (*e.g.*, Table 24). The teaching assistant group performed best in multiple dimensions. For example, in terms of ensuring that all learners, including those with special needs, have access to learning resources and activities (Sq1), the average score of the teaching assistant group was 3.70±1.23, while that of the professor group was 2.21±0.80, that of the associate professor group was 2.23±0.91, and that of the lecturer group was 2.51±1.10 (F=36.585, *p*=0.000).

In addition, the teaching assistant group scored the highest in considering and responding to learners' expectations, abilities, and contexts for using digital technology (Sq2, 3.45±1.18) and using digital technology to meet learners' different learning needs (Sq3, 3.51±1.14), which was significantly higher than other groups. The lecturer group also scored higher than the professor group and the associate professor group in these dimensions, indicating that lecturers and teaching assistants were more involved in these aspects.

These results show that teaching assistants and lecturers are more active in empowering learners, while professors and associate professors are relatively less engaged in these aspects. This highlights the need to improve teachers' ability to empower learners in a targeted manner at different levels of professional titles.

Table 24. One-Way ANOVA of Different Job Titles in the Dimension of Empowering Learners

	Your job title: (mean ± standard deviation)					F	p
	Professor (n=39)	Associate Professor (n=158)	Lecturer (n=257)	Teaching assistant (n=110)	Others (n=2)		
Sq1	2.21±0.80	2.23±0.91	2.51±1.10	3.70±1.23	1.50±0.71	36.585	0.000**
Sq2	1.85±0.84	2.08±0.96	2.23±1.06	3.45±1.18	2.00±0.00	35.989	0.000**
Sq3	2.10±0.85	2.11±0.95	2.46±1.09	3.51±1.14	2.00±0.00	32.393	0.000**
Sq4	1.79±0.77	2.11±0.94	2.31±1.12	3.61±1.12	1.50±0.71	43.078	0.000**
Sq5	2.21±0.89	2.13±0.96	2.41±1.15	3.69±1.15	2.00±0.00	38.553	0.000**

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Sq6	2.00±0.79	2.17±1.04	2.38±1.13	3.50±1.01	2.00±0.00	31.411	0.000**
* p<0.05 ** p<0.01							

(6) Promoting learners' digital capabilities

Table 25. One-Way ANOVA of Different Job Titles in Promoting Learners' Digital Competence Dimensions

	Your job title: (mean ± standard deviation)					F	p
	Professor (n=39)	Associate Professor (n=158)	Lecturer (n=257)	Teaching assistant (n=110)	Others (n=2)		
Cj1	1.95±0.79	2.22±0.99	2.39±1.13	3.59±1.08	1.50±0.71	35.613	0.000**
Cj2	1.97±0.87	2.07±0.95	2.38±1.12	3.58±1.02	1.50±0.71	40.287	0.000**
Cj3	2.08±0.93	2.04±1.00	2.39±1.19	3.68±1.22	1.00±0.00	39.395	0.000**
Cj4	2.15±0.78	2.20±0.96	2.41±1.05	3.49±1.06	2.00±0.00	31.463	0.000**
Cj5	1.92±0.77	2.25±0.90	2.50±1.03	3.50±1.11	2.00±0.00	32.569	0.000**
Cj6	2.05±0.86	2.23±1.04	2.38±1.15	3.49±1.22	2.00±0.00	26.223	0.000**
Cj7	1.92±0.77	2.14±0.86	2.46±1.15	3.60±1.14	1.50±0.71	37.931	0.000**
Cj8	1.77±0.81	2.06±1.00	2.36±1.08	3.57±1.04	1.50±0.71	43.100	0.000**
Cj9	2.03±0.90	2.06±1.01	2.33±1.14	3.54±1.32	2.00±0.00	32.387	0.000**
* p<0.05 ** p<0.01							

According to data analysis, teachers with different titles showed significant differences in the dimensions of promoting learners' digital competence (Cj1-Cj9) (*p*<0.05) (*e.g.*, Table 25). The teaching assistant group performed best in multiple dimensions. For example, in terms of incorporating learning activities, assignments, and assessments that require learners to clearly express their information needs (Cj1), the average score of the teaching assistant group was 3.59±1.08, while the professor group was 1.95±0.79, the associate professor group was 2.22±0.99, and the lecturer group was 2.39±1.13 (F=35.613, *p*=0.000).

In addition, the teaching assistant group scored the highest in cultivating students' information and media literacy (Cj2, 3.58±1.02) and using digital technology for communication, collaboration, and civic participation (Cj3, 3.68±1.22), which was significantly higher than other groups. The lecturer group also scored higher than the professor group and the associate professor group in these dimensions, indicating that lecturers and teaching assistants were more involved in these aspects.

These results show that teaching assistants and lecturers are more active in promoting learners' digital competence, while professors and associate professors are relatively less involved in these aspects. This highlights the need to specifically enhance teachers' ability to promote learners' digital capabilities at different professional title levels.

4. Results

4.1 Age Differences

The scores show large differences in digital literacy among people of all grades and ages. Teachers aged 26-35 are considered the most skilled in all fields, with an average score much higher than those aged 36 and above. This means that young teachers are very digitally literate, whereas middle-aged and elderly teachers perform poorly in digital literacy.

4.2 Teaching Experience Differences

There are significant differences in digital literacy among teachers with different years of teaching experience across each dimension. For each dimension of the scores, teachers with 0–5 years experience rank highest and have average scores that are significantly better than more experienced educators. This suggests that newer teachers are more adept and enthusiastic with digital techs, while veterans may require additional instruction to improve their digital literacy.

4.3 Educational Background Differences

In some aspects of digital literacy, there are considerable differences between teachers with different educational qualifications. Associates degree holding teachers outperform their higher-degreed peers on scales like professional engagement[5], use of digital

resources and of them in teaching practices/learning activities as well enhancing the above abilities (assessment, fostering learners' digital competence or awareness about literacy). Quantitative literacy enhancement ability and overall consideration of digital content. However, when it comes to empowering learners, there are no significant differences between teachers with different educational levels[6]. This suggests that while education level does indeed influence digital literacy, the gaps are not as apparent across all domains.

4.4 Academic Title Differences

There are huge differences in digital literacy between teachers with different academic titles, and in many aspects assistant lecturers are the best, followed by lecturers and then associate professors at the bottom.

5. Research Conclusions and Recommendations

5.1 Conclusions

This study reveals that there are large variations in the digital literacy of e-commerce teachers based on their age, teaching experience, educational background and academic rank. In general, younger and less experienced staff, those with an associate degree or lower academic titles of teachers are better performing on all sections of digital literacy. On the contrary, middle-aged and elderly teachers, more years of teaching experience, higher degree education background, higher academic titles in that increasing their digital literacy level are relatively low.

5.2 Recommendations

Create Digital Literacy Training that is Highly Relevant to a Broad Array of Teachers There should be specially curated training programs and exercises to uplift the digital literacy of middle-aged, senior teachers with longer teaching tenure/academic experience. Encourage collaboration among teachers across different ages and titles for knowledge exchange and digital skill transfer. Include digital literacy indicators in the teacher evaluation and pay schemes that will encourage more educators to enhance their digital capabilities to explore more factors that influence digital literacy of teachers and how they can effectively integrate teaching e-commerce using technology in their pedagogy to enhance the teaching quality.

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