Enhancing Digital Literacy of E-Commerce Teachers: A Paired Sample T-Test Analysis of Training Effectiveness

Zhang Jing[1,2], Almira. M[2,*]
[1]*Guangzhou Huashang College, Guangzhou, Guangdong, China*
[2]*Graduate University of Mongolia, Ulaanbaatar15141, Mongolia*
**Corresponding Author.*

Abstract: Based on the theoretical basis of TPACK and DigCompEdu, this paper designs an effective structured training course aiming at improving the digital literacy of college teachers involved in E-commerce courses based on the actual situation of colleges in Guangdong province. After a period of five days' training, there are totally four hundred and eleven participants from different universities taking part in it, which covers three main contents including big data analyzing tool application, Digital resources managing skills and Technology integration into pedagogical practice. According to pre-test and post-test results analyzed through Paired Sample t-test method, ten out of twelve indicators have been improved significantly ($p<0.01$), indicating that these participants can effectively reduce their digital literacy gap between theory and practice, improve their teaching efficiency as well as promote the professional competence of them. In addition, considering its positive impact on improving the professional competence of E-commerce teachers, we suggest that similar programs should be promoted widely among all high schools in China so as to meet current market needs and speed up the process of promoting educational reform via digitalization.

Keywords: Teachers' Digital Literacy; E-Commerce Teachers; Paired Sample T-Test

1. Introduction

1.1 Research Background

The digitalization of education is an inevitable trend in the era of globalization and information technology. Not only does educational content require the support and application of digital technologies, but teaching methods and management approaches are also evolving accordingly. The development of e-commerce has driven the increasing demand for electronic information technology. In this context, universities must cultivate students with fundamental competencies, and enhancing the digital literacy of teachers has become an urgent necessity [1].

From the perspective of teachers' professional development, the digital literacy of e-commerce educators directly impacts teaching quality and students' professional competencies. Teachers with strong digital literacy and technical skills can enhance course design, stay abreast of industry trends, and integrate cutting-edge technologies such as VR into classroom teaching and AI-driven learning into educational reform. Additionally, data-driven research facilitates the integration of theory and practice, thereby improving both academic capabilities and teaching quality.

Digital literacy is not only a pressing need in e-commerce education but also a crucial requirement for the development of modern education in China. It contributes to the balanced allocation of educational resources, the expansion of online learning opportunities, and the promotion of lifelong learning [2]. Strengthening the digital literacy of e-commerce educators is of great significance in improving teaching quality and advancing the digital transformation of education.

1.2 Problem Statement

Currently, research on the digital literacy of e-commerce teachers is limited, and there is a lack of empirical evaluation of training interventions. In particular, deficiencies remain in the integration of technology, pedagogy, and content knowledge (TPACK) (Li Yanxia et al., 2016; Wang Haitao et al., 2018a). With the increasing demand for e-commerce education under the "Internet Plus" strategy, the need for developing students' digital skills is also growing,

highlighting the issue of insufficient faculty capabilities.

"Although China has established a relatively large-scale talent cultivation system for e-commerce education and achieved notable progress (Yang Yongchun, 2019), effectively enhancing teachers' professional development remains a pressing challenge."

This study designs a targeted five-day training program to explore effective approaches and strategic pathways for improving teachers' digital literacy. By conducting pre- and post-training assessments of participants, the study evaluates the effectiveness and impact of the program and proposes action recommendations to promote sustainable development.

1.3 Research Purpose

The primary objectives of this study are to conduct a validation analysis of the proposed training model, assess its effectiveness, and formulate practical policy recommendations based on the findings. Specifically, the study aims to:

(1) Empirically examine the application of learning theories based on learning needs, task-driven approaches, and collaborative inquiry.

(2) Explore and practice pathways for enhancing teachers' digital literacy, providing a reference for the digital literacy development of e-commerce faculty in higher education institutions, and establishing a universally applicable instructional design model.

(3) Evaluate the effectiveness and feasibility of the training program through experimental results and data analysis, and formulate corresponding strategic measures to promote higher education reform in China.

2. Theoretical Framework

2.1 Teachers' Digital Literacy

Gilster (1997) first introduced the concept of "digital literacy," defining it as the ability to understand and use complex information presented by computers. However, Kenton & Blummer (2010) pointed out that current definitions of the term often equate digital literacy with basic technical skills, and its scope remains unclear. JISC (2014) further clarified that "digital capabilities are essential for everyone to survive, learn, and work in a digital society." This highlights that digital competence is a fundamental requirement for conducting academic research, writing reports, and engaging in critical thinking using various digital tools.

The IFLA (2017) Statement on Digital Literacy emphasized that "digital literacy" encompasses a broad spectrum of concepts, ranging from basic digital skills and applications to more advanced aspects such as coding and critical thinking.

"Teachers' digital literacy" refers specifically to educators and is defined as "the ability to acquire, process, and apply various information resources in the field of education". The International Federation of Library Associations and Institutions (IFLA) states that "teachers' digital literacy includes not only basic technical skills but also comprehensive abilities such as discovering, utilizing, managing, and evaluating digital information and resources."

In 2023, China's Ministry of Education released the Industry Standards for Digital Literacy of Primary and Secondary School Teachers, explicitly stating that "teachers must possess the ability to analyze and solve educational and teaching problems and innovate teaching methods." This marks the first time the country has outlined, at a macro level, the specific aspects of digital literacy that teachers need to master. This initiative not only provides a clear direction for improving teacher quality but also positions teachers as both learners and service providers in the digital society.

This study uses several key abbreviations to represent different dimensions of digital literacy. Tk0 - Tk (Technological Knowledge), Ck0 - Ck (Content Knowledge), and Pk0 - Pk (Pedagogical Knowledge) align with the TPACK framework, while Tp0 - Tp represents Technological Pedagogical Content Knowledge. From the DigCompEdu framework, Zy0 - Zy (Professional Engagement), Sz0 - Sz (Digital Resources), Jy0 - Jy (Teaching and Learning), Pg0 - Pg (Assessment), Sq0 - Sq (Empowering Learners), and Cj0 - Cj (Facilitating Learners' Digital Competence) capture various aspects of digital teaching. Finally, Cl0 - Cl (Digital Literacy Improvement Capability) assesses teachers' ability to enhance their digital competencies.

2.2 TPACK Model

Specifically, the TPACK model emphasizes that teachers should integrate Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) in a cohesive manner (Figure 1: TPACK Model).

First, teachers need to master various technological tools and resources. Second, they should understand and apply diverse teaching approaches and methods. Third, they must have a deep comprehension of the subject content. The integration of these three types of knowledge leads to the formation of new knowledge domains: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK).

Ultimately, the goal is to achieve the full integration: PCK + TK + CK = Technological Pedagogical Content Knowledge (TPACK). This comprehensive framework enhances teaching quality, enabling educators to effectively adapt to various educational environments and meet diverse learning needs.

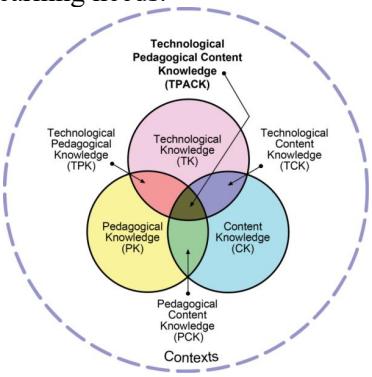

Figure 1. TPACK Model

The TPACK model provides a theoretical foundation for enhancing the digital literacy of e-commerce teachers in higher education. By integrating Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) into a comprehensive professional knowledge framework, the model facilitates the effective integration of digital tools into the teaching process. This not only helps e-commerce educators seamlessly incorporate information technology into their instruction but also enables them to conduct more effective teaching activities, ultimately improving classroom teaching quality [3]. The specific applications of the TPACK model are presented in Table 1.

3. Research Methods

3.1 Literature Research

This study employs a literature review method to systematically collect, organize, and analyze relevant research findings, providing a theoretical foundation and research background for the dissertation. The databases searched include CNKI (China National Knowledge Infrastructure), Wanfang Data Resource System, and Google Scholar. The primary references consist of high-quality academic papers, monographs, and research reports. The study explores key aspects such as the definition and evaluation criteria of digital literacy, effective approaches to improving teachers' digital literacy (e.g., training programs, continuing education, and practical teaching), and influencing factors at the individual, environmental, and technological levels [4].

By reviewing, analyzing, and synthesizing the collected literature, this study identifies key research perspectives and examines the significance of digital literacy in enhancing the teaching capabilities of e-commerce educators. A current situation survey is conducted to assess the development level of digital literacy among e-commerce teachers in Guangdong Province, as well as the challenges they face. Based on these findings, recommendations are proposed to improve the e-commerce teacher training system and promote the digitalization of education [5].

Furthermore, the study highlights existing gaps in the research on this topic, such as methodological limitations and sampling biases, thereby clarifying research trends and future directions in this field. It also identifies the study's innovative contributions and significance. Finally, based on the theoretical framework, an overall structure diagram of the dissertation is constructed (see the next page), providing a foundation for the empirical research section.

3.2 Case Method

This study adopts a case study approach to cultivate the teaching practice abilities of e-commerce educators in Guangdong Province during the process of enhancing their digital literacy. A five-day teaching practice program was designed based on the TPACK model and the European Framework for the Digital Competence of Educators (DigCompEdu) [7]. The training covered key topics such as the application of data processing tools, principles of e-commerce website design, and user experience (UX) design [8].

By integrating theoretical learning with hands-on practice, the program aimed to help teachers master digital tools such as Excel, SPSS, Google Analytics, Photoshop, and Wireframe. This approach enhanced their digital teaching

competencies and ability to apply digital educational resources, ultimately improving classroom teaching effectiveness and enriching student learning experiences [9].

The selection criteria of subjects: 458 people were chosen as participants; both pre-test questionnaire and post-test questionnaire are adopted to measure whether or not the effect is significant. The sampling method: The research group first selected 458 teachers who have participated in the course online, then we chose those whose answers are valid by deleting some unqualified questionnaires which make no sense. The total number of samples that can be analyzed effectively reaches 411.Analysis Method: In order to better analyze the relationship between digital literacy and teaching activity, an analytic framework diagram has been developed based on the data collected through the survey. It will serve as a guide for educators to improve themselves continuously in the field of digital literacy, so it could help us build up a continuous learning system and professional development platform [6]. This work would contribute more than just helping students understand the concept of digital literacy but also helps them realize how important they should keep improving in all aspects including their digital literacy level because only when our teachers learn well about the digital world and use these technologies properly during class, we can achieve higher quality and efficiency in e-commerce education.

Table 1. Application Framework of TPACK Model in Improving Digital Literacy of College E-Commerce Teachers

Dimensions	definition	Specific applications	Actual Cases
Technical knowledge (TK)	Teachers' knowledge of designing and supporting instruction using a variety of technology tools and software.	Understand and use big data, artificial intelligence, blockchain, etc.	Using big data analysis tools for market analysis
Pedagogical Knowledge (PK)	Teachers' knowledge of teaching methods, pathways, and assessing student learning outcomes.	Adopt case teaching, project teaching, flipped classroom, etc.	Analyze e-commerce cases through case teaching
Content Knowledge (CK)	Teachers have a deep understanding and mastery of the subject content they teach.	Master e-commerce platform operations, online marketing, electronic payment systems, etc.	Explain the operation method of e-commerce platform
Teaching Content Knowledge (TCK)	Use information technology to explain subject knowledge content so that students can have a deeper understanding of subject content knowledge.	Using technology tools to enhance teaching effectiveness	Using blockchain technology to explain the security of electronic payments
Technical Content Knowledge (TPK)	Knowledge generated from the interaction between technology and general pedagogy, including the selection and use of appropriate technological means to accomplish instructional tasks.	Optimizing teaching methods and pathways	Utilize online learning platforms for course management and interaction
Technology Pedagogical Content Knowledge (TPACK)	Integrate knowledge of technology, pedagogy, and subject content for effective teaching.	Integrating technology and teaching pathways	Conduct market research projects using big data analysis tools.

Source: https://tpack.org/

3.3 Paired Sample T-Test Method

A paired sample t-test is used to compare the mean differences of the same group under different conditions and to assess the effects of an intervention or time-related changes. In this study, the author will use the paired sample t-test to evaluate the effectiveness of the training program. By comparing the pre- and post-training digital literacy scores of the same group of teachers and analyzing the statistical significance of the differences, the study aims to determine whether the training has significantly improved their digital literacy levels.

The specific procedure involves pairing the pre- and post-training scores of the same group of participants and computing the mean difference along with relevant statistical indicators. If the results show a statistically significant improvement, it can be concluded that the

training had a positive impact on the digital literacy of the participating teachers.

Implementation Process:

(1) Data Collection: Gather digital literacy measurement data from teachers before and after training.

(2) Descriptive Statistics: Calculate the mean and standard deviation of both datasets.

(3) Statistical Testing: Use SPSS software to conduct the paired sample t-test, obtaining the t-value and p-value (significance level).

(4) Result Interpretation: Analyze the statistical output to determine whether there is a significant difference and evaluate the effectiveness of the training program.

To achieve the above objectives, the research methodology and statistical analysis are aligned with the study's framework and survey data. The rationale and detailed process of using the paired sample t-test have been elaborated in Sections 2, 3, and 4. By comparing pre- and post-training digital literacy levels, the study provides clear and reliable results, allowing the author to assess the practical effectiveness and feasibility of the training program. This, in turn, facilitates further refinement of the course design for future implementations.

4. Empirical Research

4.1 Case Introduction

4.1.1 Case introduction

This five-day training program aimed to enhance the digital literacy of e-commerce teachers by providing systematic theoretical learning and practical exercises in data analysis, website design, and user experience. The training covered tools such as Excel, SPSS, Google Analytics, Photoshop (PS), and Wireframe, along with e-commerce website design principles and UX design, equipping teachers with the latest teaching methods and technologies.

The program sought to improve teachers' ability to utilize digital resources, innovate teaching methods, and empower students with enhanced learning experiences and digital skills. Ultimately, it aimed to establish a platform for continuous learning and professional development, ensuring that teachers could apply their newly acquired knowledge to real-world teaching scenarios and enhance the quality of e-commerce education.

4.1.2 Training schedule overview

The training content is divided into five days and five topics. The first day is data analysis tools; the second day is website analysis; the third day is image processing technology; the fourth day is web design and production; the fifth day is HTML language basics and the use of network application software. The main courses are: (1) data collection and analysis tools; (2) website analysis; (3) image processing technology; (4) web design and production; (5) HTML language basics and the use of related network application software, etc.

Day 1: Application of Excel in E-Commerce Data Analysis

The training introduced the important role of Excel in e-commerce teaching, covering basic operations and data processing methods. Teachers engaged in case-based analysis and hands-on practice, learning how to utilize Excel to process and analyze e-commerce related data, providing more effective data support tools for teaching.

Day 2: Application of SPSS in Data Analysis

The training began with a review of Excel learning outcomes before introducing the SPSS statistical analysis software. Through e-commerce cases, teachers learned various data analysis methods and discussed how to integrate SPSS into teaching practices, enhancing students' data analysis capabilities and skills for understanding complex data.

Day 3: Google Analytics for E-Commerce Website Analysis

The training provided an overview of Google Analytics features and key metrics, with teachers participating in practical exercises in website data analysis. By exploring data-driven teaching strategies, teachers learned how to use website analytics tools to understand user behavior and apply these insights to e-commerce teaching.

Day 4: Photoshop for E-Commerce Image Design

The training introduced Photoshop tools and editing techniques, with teachers engaging in practical exercises in e-commerce-related image design. Through discussions on integrating graphic design into teaching, teachers enhanced their visual design skills to better guide students in creating professional e-commerce visual content.

Day 5: Wireframe for Website Design

The training explained Wireframe principles and design methods, with teachers participating in practical exercises in website framework design.

By discussing the role of Wireframe in teaching, teachers learned how to use this tool for website planning and user experience design, providing more comprehensive website development instruction for students.

4.1.3 Expected outcomes

This training aimed to enhance teachers' digital literacy by equipping them with essential digital tools and improving their abilities in data analysis and design. Through hands-on practice and case discussions, teachers were encouraged to innovate their teaching methods and continuously develop their skills for long-term professional growth.

4.2 Paired Sample T-Test

In this section, the author uses paired sample T-test to compare the data of each sample before and after training, and through the analysis of experimental data, determines whether the digital literacy of each sample after training has been significantly improved.

4.2.1 Hypothesis testing

In this section, the researcher employs the paired sample T-test to analyze and compare data from each sample prior to and following the training. Through the examination of experimental results, it is determined whether there has been a significant enhancement in digital literacy for each sample post-training.

4.2.2 Hypothesis testing

The procedure for hypothesis testing begins with formulating reasonable assumptions regarding the population in question. Subsequently, a sampling survey is conducted to assess the validity of these preliminary assumptions. Hypothesis testing is categorized into parametric and non-parametric testing. In cases where the distribution of the population is known (e.g., normal distribution), the subsequent inferences made are classified as parametric testing. Conversely, when the population distribution remains unidentified, non-parametric testing is typically applied. Typically, hypothesis testing is necessitated when the sample size is fewer than 30. However, even with larger sample sizes, a normality test was performed using SPSS (refer to Section 4.2.3) to verify that the data satisfies the conditions for parametric testing.

4.2.3 Paired sample t-test

The paired sample T-test serves as a robust technique for conducting parametric examinations. It assesses whether two sets of related sample data originate from a normally distributed population exhibiting identical mean values, effectively determining if the means from the two interconnected sample populations differ significantly. The null hypothesis posited is H0: u1 - u2 = 0, where u1 and u2 represent the means of the first and second populations, respectively. The concept of pairing indicates a one-to-one relationship between sample values in both data sets, as well as an associative connection, with both groups of samples being equivalent in size. These paired samples may represent the "before" and "after" stages of a particular property of an object or can illustrate two contrasting facets or perspectives of a single subject.

In the paired sample T test, let X_{1i}, X_{2i} (i=1,.....,n) be paired samples. The sample difference $d_i = X_{1i} - X_{2i}$, and the test statistic is:

$$t = \frac{\bar{d} - (u1 - u2)}{S/\sqrt{N}} \quad (1)$$

In the formula, $\bar{d}$ is the mean of d_i; S is the standard deviation of d_i; N is the number of samples. When $u_1 - u_2 = 0$, the t statistic follows a T distribution with N-1 degrees of freedom.

The difference between the two groups of samples can be calculated in the statistical analysis software SPSS, and the corresponding data can be substituted into the T-test statistical formula in the above formula to calculate the observed value of the statistic and the corresponding probability P value.

4.2.4 Normal distribution test and significance definition of experimental data

The paired sample T test belongs to a type of parameter test, and the parameter test requires the premise that the known population distribution is a normal distribution. Therefore, firstly, a descriptive statistical analysis - exploratory analysis - is performed on the experimental data sample to test whether each parameter satisfies the normal distribution. As shown in the following table, when P>0.05, it is considered that there is no statistical difference; when P<0.05, it is considered that there is a statistical difference; when P<0.01, it is considered that there is a significant statistical difference; when P<0.001, it is considered that there is an extremely significant statistical difference (*e.g.*, Table 2. Paired Sample T Test Probability P Value Significance Definition).

Table 2. Paired Sample T Test Probability P Value Significance Definition

P value range	Definition of Significance

> 0.05	No statistically significant difference
< 0.05	There is a statistical difference
< 0.01	There is a statistically significant difference
< 0.001	There is a statistically significant difference

Source: collated by the author

In this study, SPSS statistical analysis software was used to test the normality of the distribution. After testing, all dimensions were found to be in line with the normal distribution.

4.2.5 Experimental results

Tested the data before the experiment (Tk0, Ck0...Cl0) and the data after the experiment (Tk, Ck. Cl) (*e.g.*, Table 3. Paired Sample T-Test Results).

Analyzing the paired sample T test results in the table below, we can see that in all the pairs, except pair 11 (Cl0 - Cl), the mean differences of other pairs are negative, which indicates that in most cases, the first measurement value (such as Tk0, Ck0, etc.) is higher than the second measurement value (such as Tk, Ck, etc.). For each pair, we focus on the t value and P value, which help us determine whether these mean differences are statistically significant.

In pairs 1 to 10, the t values are all negative and the P values are all less than 0.01, indicating that there are extremely significant statistical differences in these pairs. For example, the t value of pair 2 (Ck0 - Ck) is -4.125 and the P value is <0.001, indicating that the difference between Ck0 and Ck is very significant. Similarly, the t value of pair 9 (Sq0 - Sq) is -4.948 and the P value is <0.001, indicating that the difference between Sq0 and Sq is also very significant.

However, the P value of pair 11 (Cl0 - Cl) is 0.042, which exceeds the commonly used significance level of 0.05, so it is not considered statistically significant that there is a significant difference between Cl0 and Cl. In addition, its 95% confidence interval includes 0, indicating that it is impossible to determine whether there is a real mean difference between Cl0 and Cl.

There are several possible explanations for why Pair 11 (Cl0 - Cl) did not reach statistical significance. First, this indicator may represent a dimension of digital literacy that is relatively stable or difficult to improve in the short term, such as skills that require long-term experience or practice to develop significantly. Additionally, the initial level of this dimension may have already been relatively high, leaving little room for noticeable improvement through the training program. Another possible reason is that this aspect of digital literacy was not sufficiently covered in the training curriculum, or the instructional methods employed were not particularly effective in fostering improvements in this area. Furthermore, measurement-related factors could have played a role, as uncertainties or errors in assessing this particular competence might have obscured actual changes, making it difficult to detect a statistically significant difference.

Overall, the results of the paired sample T-tests indicate that for most indicators, there are statistically significant differences between pre- and post-experiment measurements. This suggests that the observed changes are likely influenced by experimental conditions or other contributing factors rather than random errors. Therefore, it can be inferred that the training program has been effective in enhancing teachers' digital literacy. However, the statistical insignificance of Pair 11 (Cl0 - Cl) suggests that improvements in this particular dimension may be constrained by factors such as the duration of the training, the specificity of the training content, or the inherent characteristics of the skill itself. Future training programs could be optimized to provide more targeted support for this specific dimension, ensuring a more comprehensive enhancement of teachers' digital literacy.

Table 3. Paired Sample T-Test Results

	name	Mean	Standard Deviation	Standard error of the mean	95% confidence interval of the difference		T	P
					Lower limit	Upper limit		
Pair 1	Tk0- Tk	-0.24331	1.48369	0.07318	-0.38717	-0.09944	-3.325	<.001
Pair 2	Ck0- Ck	-0.32056	1.5754	0.07771	-0.47332	-0.1678	-4.125	<.001
Pair 3	Pk0- Pk	-0.22019	1.56491	0.07719	-0.37194	-0.06845	-2.853	0.002
Pair 4	Tp0- Tp	-0.2165	1.548	0.0764	-0.3666	-0.0664	-2.836	0.002
Pair 5	Zy0- Zy	-0.20377	1.50901	0.07443	-0.35009	-0.05745	-2.738	0.003
Pair 6	Sz0- Sz	-0.26277	1.51285	0.07462	-0.40947	-0.11608	-3.521	<.001
Pair7	Jy0- Jy	-0.22689	1.54409	0.07616	-0.37661	-0.07716	-2.979	0.002
Pair 8	Pg0- Pg	-0.28285	1.50825	0.0744	-0.42909	-0.1366	-3.802	<.001

Pair 9	Sq0- Sq	-0.3753	1.53777	0.07585	-0.52441	-0.2262	-4.948	<.001
Pair10	Cj0- Cj	-0.24027	1.57076	0.07748	-0.39257	-0.08796	-3.101	0.001
Pair11	Cl0 - Cl	-0.14051	1.64572	0.08118	-0.30009	0.01907	-1.731	0.042

Source: collated by the author

5. Conclusion

5.1 Research Findings

This study demonstrates that a structured, practice-oriented training program significantly enhances the digital literacy of e-commerce teachers, as evidenced by paired sample T-test results. Key findings include:

(1) Training Effectiveness: The five-day program, integrating tools such as Excel, SPSS, Google Analytics, and Wireframe, led to statistically significant improvements in 10 out of 11 measured dimensions of digital literacy ($p<0.01$). Notable advancements were observed in technical skills (e.g., data analysis), pedagogical integration (e.g., case-based teaching), and content knowledge application (e.g., e-commerce platform operations).

(2) TPACK Model Utility: The integration of the TPACK framework and DigCompEdu standards provided a robust theoretical foundation for designing training content, emphasizing the synergy between technology, pedagogy, and subject-specific knowledge.

(3) Data-Driven Insights: Negative mean differences in pre- and post-test scores (e.g., Tk0-Tk =-0.24) suggest potential self-assessment biases or heightened post-training awareness of skill gaps. The non-significant improvement in one dimension (Cl0-Cl, $p=0.042$) highlights the need for tailored interventions in areas such as collaborative learning or industry alignment.

(4) Demographic Neutrality: Single-factor difference analysis revealed that improvements in digital literacy were consistent across diverse demographic groups (age, teaching experience, academic title), underscoring the universal applicability of the training approach.

5.2 Practical Suggestions

Accordingly, based on the outcomes presented above, it is proposed that enhancing digital literacy among e-commerce educators should be addressed by harnessing interrelated action from these three different planes. Firstly, university institutions have to build secure digital-literacy ecosystems offering frequent workshops, peer mentoring, and AI feedback along with designing particular special-purpose labs emulating actual tools in usage of professionals.

Secondarily, it needs focus efforts like building digital-portfolios/micro-credentials for personal learning improvement amongst individual teachers alongside deep engagement activities connecting better industries/experts involving more real-world projects embedding even live e-commerce promotions to respective courses designed/recommended within. Finally, policy-wise efforts can seek integration/inclusion of such benchmarks concerning required digital-literacy levels/benchmarks being part of forthcoming/updated nationwide teacher certification reform agenda besides seeking targeted/fair allocations for reaching-out less-funded establishments.

Such multifaceted strategies aim at providing a possible/effectual action-pathway towards ensuring continued advancements and upgradation for quality-of-faculty-led e-commerce courses educationally in dynamic/post-pandemic circumstances especially for the digital-generation pupils/workforce facing constant challenging/survival-oriented disruptions amidst modern/unpredictable industry-trends nowadays worldwide.

5.3 Conclusion

This study confirms that a structured, hands-on training program is an effective means of enhancing the digital literacy of e-commerce teachers. By incorporating a carefully designed curriculum based on the TPACK model and DigCompEdu standards, the training program successfully improved various digital competencies. The significant pre- and post-test score differences underscore the positive impact of this approach, demonstrating its value in preparing educators for the digital demands of modern education.

Although the training proved effective in most dimensions, the lack of significant improvement in one aspect (Cl0 - Cl) suggests that certain competencies, particularly those related to collaborative learning and industry alignment, may require more specialized and extended interventions. Future training programs should address these gaps by incorporating targeted modules that emphasize teamwork, digital collaboration, and industry-academic partnerships.

Furthermore, the demographic-neutral impact of the training suggests that such programs can be broadly

implemented across diverse teaching populations. This highlights the potential for scalability, ensuring that a wide range of educators can benefit from similar digital literacy initiatives.

In light of these findings, this study advocates for a holistic, multi-stakeholder approach to digital literacy development. By integrating institutional initiatives, individual learning strategies, and supportive policy frameworks, the education sector can ensure that e-commerce educators remain adaptable in the face of technological advancements. Ultimately, these efforts will not only enhance teaching effectiveness but also better prepare students for the evolving digital economy, bridging the gap between academic education and industry demands.

This research provides valuable insights for universities, educators, and policymakers, serving as a foundation for future studies on digital literacy training in higher education. The ongoing digital transformation requires continuous adaptation, and by embracing structured training programs, educators can remain at the forefront of digital innovation, fostering a more competent and digitally literate academic community.

Acknowledgements

Guangzhou Huashang College Youth Academic Research Project: "Research on the Evaluation Index System of Digital Literacy of Private University Students Based on Principal Component Analysis" [Project No.: 2023HSQX043].

References

[1] Hatlevik O E. Digital literacy among Norwegian teachers: Predicting teachers' confidence in, and use of digital technology in teaching. Computers & Education 2016, 97, 1-10.

[2] Ren Y Q. Research on the EU digital literacy framework. Open Education Research, 2016, 22(5): 37-46.

[3] Liu B Q, Yin H H. Artificial intelligence empowers teachers to improve digital literacy: path, scenario and evaluation feedback mechanism. Modern Educational Technology, 2024, 34(7): 23-30.

[4] Gu C F, Chen L. Research on improving digital literacy of primary and secondary school teachers from the perspective of educational ecology. Educational Theory and Practice, 2024(14): 41-46.

[5] Wang W, Yan H B. Design characteristics of Harvard University's Data Intelligence Project and the Netherlands' Data Team Project. Educational Technology Research, 2023, 12(4): 45-52.

[6] Mishra P, Koehler M J. Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Teachers College Record, 2006, 108(6), 1017-1054.

[7] Gutierrez-Angel N, Sanchez-Garcia J N, Mercader-Rubio I, et al. Digital literacy in the university setting: A literature review of empirical studies between 2010 and 2021. Frontiers in Psychology, 2022, 13, 896800.

[8] Hanif E. Empowering EFL learners: The impact of digital literacy in blended English language teaching method. Berajah Journal 2024, 15.

[9] Xu H. Review of the development of digital literacy training models in the United States, Europe, Japan and my country. Journal of Distance Education, 2023, 41(3): 24-32.

