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The impact of digital learning resources, teacher support, and peer collaboration on academic performance of vocational and technical college students in China

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Abstract

This study investigated the impact of digital learning resources, teacher support, and peer collaboration on academic performance among vocational and technical college students in China. Adopting a quantitative descriptive-correlational study design, data were collected from 760 students across three vocational colleges in Shenzhen, Guangdong Province, China. Data were statistically analyzed through SPSS 26.0, employing correlation and multiple regression analyses. Correlation results indicated strong positive correlations between all of the variables and academic performance as follows: digital learning resources, teacher support, and peer collaboration. The regression model explained 46.2% of the explained variation of academic performance, and teacher support was the most significant predictor, followed by digital learning resources and peer collaboration. Results confirm an integrative theoretical framework of Social Cognitive Theory, Technology Acceptance Model, and Social Learning Theory. The study depicts that the effectiveness of vocational education entails holistic measures combining technological advancement, extensive teacher support and collaborative learning opportunities. The findings provide evidence-based implications for education administrators and policymakers to facilitate student success strategically through resource allocation and enhancement of teaching methodologies.

Keywords: Academic performance, Education policy, Peer collaboration, Teacher support, Vocational education.

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1. Introduction

The contemporary educational landscape in China has undergone profound transformations over the past three decades, fundamentally reshaping both higher education and vocational technical education systems. China's higher education sector has experienced unprecedented expansion since the late 1990s, with enrollment increasing from 3.4 million students in 1998 to over 44 million in 2020, representing one of the world's largest higher education systems. This massive expansion has been accompanied by significant quality improvements, infrastructure development, and internationalization efforts, positioning Chinese higher education institutions among the world's top-ranked universities. The government's substantial investments in research universities, exemplified by initiatives such as Project 985 and Project 211, have created world-class research institutions while simultaneously driving innovation in educational methodologies and technological integration across all educational levels.

Parallel to higher education development, China's vocational and technical education sector has emerged as a critical component of the national economic development strategy, serving as a vital pathway for developing skilled workforce capabilities essential for supporting the country's transition toward a knowledge-based economy [1]. The vocational education system encompasses secondary vocational schools, technical colleges, and higher vocational institutions, collectively enrolling over 28 million students and representing approximately 40% of all secondary and higher education students in China. This sector has been strategically positioned to address the growing demand for skilled technicians, craftspeople, and middle-level professionals required by China's rapidly evolving manufacturing, service, and technology industries. The integration of digital technologies within both higher education and vocational education has become increasingly prominent, driven by national digitalization policies and the recognition that technology-enhanced learning environments can significantly improve educational outcomes, student engagement, and workforce preparation.

The convergence of digital transformation initiatives across China's educational sectors has created unprecedented opportunities for innovation in teaching methodologies, learning resource delivery, and student support mechanisms. The state-led "Education Informatization 2.0 Action Plan" is an overarching framework for digital technology integration at all levels of education, prioritizing the establishment of smart learning environments, evidence-informed educational decision-making, and technology-facilitated pedagogical practice [2]. This framework for educational policy has enabled significant investment in educational technology infrastructure, teacher digital skills development, and production of quality digital learning resources tailored for various educational environments. For schools of vocational and technical education, these digital innovations have been especially valuable, as these empower students to simulate complicated industrial processes, access advanced equipment and programs, and create links between learning in classrooms and professional practice in workplaces, thus making vocational education programs more relevant and efficient.

Despite extensive investments in teacher training and educational technology in China's vocational education, there are still major gaps in comprehending the precise mechanisms by which digital learning tools, teacher support, and peer-to-peer learning affect academic performance [3]. Individual-level factors are mostly studied in existing research, without investigating the interactive relationships and additive effects among these variables on student outcomes.

Chinese vocational and technical colleges are under intense pressure to prove measurable improvement in student academic performance while equipping graduates to keep up with increasingly changing industry needs [4]. Yet, there is little empirical study available of how to best integrate digital tools, effective strategies in supporting lecturers, and collaborative learning processes in the specific context of Chinese vocational education.

The lack of in-depth research that considers these factors in tandem obstructs decision-making supported by evidence for educational managers, policy-makers, and practitioners aiming to maximize resource provision and pedagogical practice [5]. Such knowledge deficit is especially worrying amidst the high public and private investments in education technology infrastructure and teacher professional growth programs for the vocational education sector in China.

Thus, the main goals of this research are to examine the effects of digital learning resources, teacher support, and collaborative learning from peers on academic performance among vocational and technical students in China. The specific research objectives are: to determine the impact of Digtal learing resourse on influence of academic performance in vocational and technical college in china; to examine the influence of teacher support on student academic performance; to assess the influence of peer interaction on student achievement.

Specifically, this study targets vocational and technical college students in China, testing the role played by digital learning tools, teacher support, and peer interactions in their academic performance. A quantitative research design is used based on validated surveys and statistical procedures to build correlations among variables.

Geographic coverage includes several technical vocational colleges in Shenzhen, China, covering several different learning environments and students to attain validity. Time scope includes observations of students' achievement as well as matching variables for current term.

Conceptual framework for this study presents hypothetical relationships among variables within a Chinese vocational school setting. Digital learning resources define the first independent variable with access, how often, and how well technology tools are perceived to affect academic performance directly by promoting learning opportunities and improved skills.

Teacher support is operationalized as the second independent factor, a four-component measure of instructional guidance, quality feedback, emotional support, and mentoring. It is hypothesized to have both direct effects on achievement and moderating effects on digital learning resources' association with achievement.

The third independent variable is peer collaboration, including formal collaborative learning experiences as well as informal peer networking. Both these are predicted to synergistically interact with digital learning resources, as well as teacher assistance, in order to promote academic performance. Dependent variable, academic performance, is measured using several indicators such as GPA, course completion percentages, as well as levels of skill acquisition.

Academic performance in vocational contexts incorporates both theoretical knowledge as well as practical skill development, as recognized within the framework. The theoretical framework comprised demographic controls (academic year, program type, age, gender) as possible predictors of strength and directionality of associations between the focal variables.

The conceptual framework (see Figure 1) also recognizes Chinese learning context as a moderator, ascertaining educational intervention efficacies shaped by cultural values, institutional structure, and teaching culture. The multidimensional framework provides direction to empirical studies and hypothesis testing in following chapters.

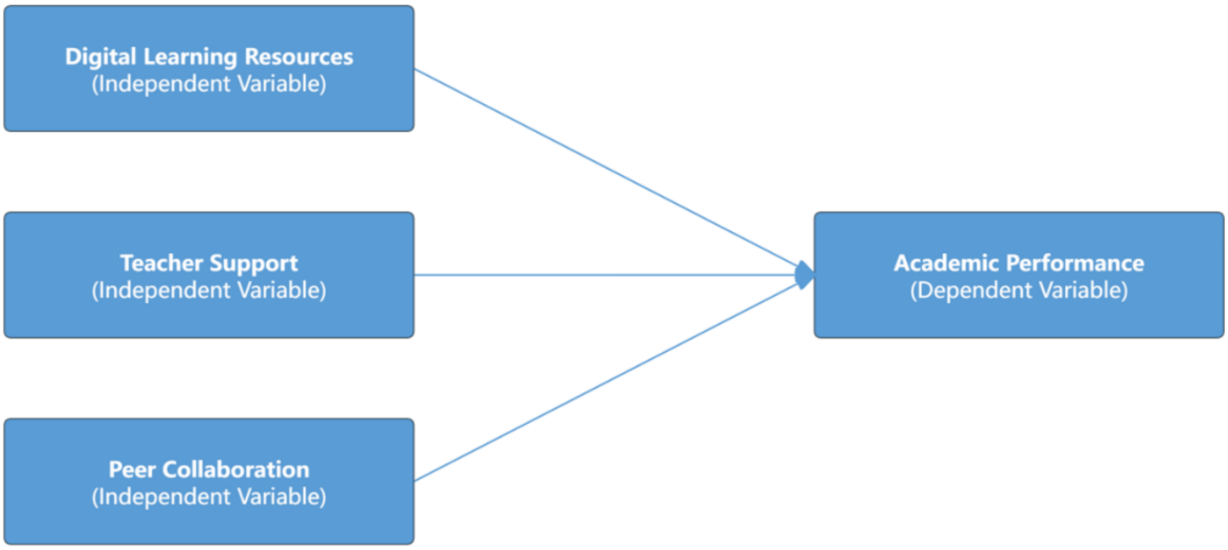

Figure 1.
Conceptual Framework.

2. Materials and Methods

This chapter outlines in detail the research methodology used to examine the effects of digital learning materials, support from teachers, and collaboration between peers on vocational and technical college students' performance in China. The methodology involves research design, population to be targeted, sampling techniques, instruments, data collection procedures, and analysis techniques used to tackle research aims in a rigorous and scholarly manner.

The quantitative approach adopted in this study allows for systematic measurement and statistical analysis of relationships between variables, providing objective and generalizable findings that can inform educational practice and policy decisions. The methodology is designed to ensure validity, reliability, and ethical compliance while maintaining practical feasibility within the constraints of educational research settings. The software used is Statistical Package for Social Sciences (SPSS) version 26.0, which also acts as primary analysis software for statistical treatment and processing of information collected. SPSS is also broadly known to be an all-inclusive and robust statistical software package having rich features for descriptive statistics, analysis of correlation and regression modeling analysis, and advanced multivariate analysis procedures [6].

2.1. Research Design

The integrated design framework for study was applied to investigate relationships between digital learning resources, guidance from teachers, collaboration among students, and academic performance among students at Chinese technical and vocational colleges. Research design components are detailed systematically in Table 1, which highlight philosophic foundations, methodological focus, and design elements that guided this study.

Table 1.
Research Design Framework.

Component	Description	Justification	Reference
Research Paradigm	Positivist	Emphasis on measurable objectives, observable phenomena, and statistical inference in establishing variable relationships	Creswell and Creswell [7]
Epistemological Foundation	Systematic observation and measurement	Ability to generate knowledge through observable phenomena and identify generalizable patterns and relationships	Saunders, et al. [8]
Research Design Type	Descriptive-correlational	Examines variable relationships while maintaining variables in natural state; provides insights into existing relationships within educational environments	Bougie and Sekaran [9]
Temporal Design	Cross-sectional	Data collection at single point in time to analyze inter-relationships efficiently without extensive resource complexity	Hair Jr, et al. [10]
Methodology	Quantitative	Systematic measurement using validated instruments for objective comparability and statistical analysis of relationships	Field [6]
Data Collection Method	Structured questionnaire	Standardized measurement procedures allowing reliable comparisons across participants	Bell, et al. [11]
Analytical Approach	Correlational and regression analysis	Capability to analyze complex interrelationships through statistical analysis with reduced researcher bias	Field [6]

The positivist paradigm was selected due to its alignment with the study goal of establishing quantifiable relationships between education variables via statistical analysis and empirical observation. The descriptive-correlational design can be applied to investigate naturally occurring relationships between associated variables without manipulating the variables and is particularly appropriate for education research environments where experimental manipulation can be unethical and/or impractical.

The cross-sectional procedure, while limiting causal inference potential, nevertheless provides much information about current relationships and trends helpful for current pedagogic usage and policy formation. The quantitative procedure allows methodologically rigorous measurement processes, allows advanced statistical explanation of relationships, and provides opportunities for generalizability with proper sampling procedures and minimizes influences of researcher bias through methodologically objective measurement processes.

The quantitative method enables systematic measurement with reliable instruments for attaining objective comparability and statistical analysis of associations [6]. The method achieves the study goals of establishing measurable consequences and giving evidence-based information for the purpose of decision-making.

2.2. Target Population

The target population comprises 760 students from three specific vocational and technical colleges in Shenzhen city, Guangdong province, China. The data collection was conducted from Shenzhen Institute of Information Technology, Guangdong Xin'an Vocational Technical College, and Shenzhen City Polytechnic. The population includes those seeking technical certificates, practical skill attainment, and professional development courses in several disciplines like manufacturing, technology, healthcare, and service.

The sample population echoes the concern of the study with vocational and technical learning environments in which digital learning materials, instructional assistance from teachers, and peer interaction might be of special significance for developing practical skills and learning performance. The selected institutions collectively enroll approximately 15,000 students, providing a substantial population base for representative sampling.

Students from these institutions are characterized by diverse demographic backgrounds, varying levels of prior educational experience, and different career preparation objectives. Students typically range in age from 17 to 21 years and are engaged in programs that combine theoretical knowledge with practical skill development to prepare them for direct entry into professional practice or continued educational advancement.

2.3. Sample Size

The sample size calculation utilized formula for finite populations [12] incorporating considerations for expected response rate and multivariate analysis requirements. The calculation process involved several key parameters and statistical considerations to ensure adequate power for planned analytical procedures.

The data collection was conducted from vocational and technical colleges from Shenzhen, Guangdong Province, China. Shenzhen, as a significant metropolitan city and special economic region, hosts a comprehensive range of vocational and technical education colleges that are strong pillars of local workforce development infrastructure. The city's vocational education profile includes approximately 35 vocational and technical colleges, including both public and private colleges. The public colleges represent about 60% of colleges and normally are funded and administered by the government, and approximately 40% are private colleges under private management but administered and accredited by the government.

The variety of institutions at Shenzhen offers an ideal research setting because such colleges admit students from varied socioeconomic backgrounds and offer courses from multiple industrial sectors like manufacturing, technology, healthcare, hospitality, and business services. Such variety of institutions ensures that the sample will include the entire spectrum of vocational education experiences and be representative of sophistication of instructional delivery mechanisms, resources, and student support services that exist for contemporary vocational education across China.

The sample size was determined using: $n = [z^2p(1-p)] / e^2$

Where n represents the required sample size, Z represents the critical value for the confidence level, r represents the response distribution, and E represents the margin of error. The calculation parameters included a target population size of 15,000 students from the three designated institutions, a confidence level of 95% (Z = 1.96), a margin of error of ±5% (E = 5), a response distribution of 70% (r = 70, based on expected variability in responses), and a predicted response rate of 85%.

Using the Raosoft sample size calculator with the above parameters, the recommended sample size for this finite population was determined to be 316 participants. This calculation automatically incorporates the finite population correction factor, which is essential when the sample size represents a significant proportion of the total population. To account for the expected response rate of 85%, the final required sample size = 316 / 0.85 = 372.

Additional considerations for multivariate analysis followed the recommendation of 15-20 participants per predictor variable [10]. With three main predictor variables (digital learning resources, teacher support, and peer collaboration) and demographic controls, a minimum of 75-100 participants would be sufficient for basic regression analysis. The 372 participants in the estimated sample significantly exceed this minimal need and provide ample statistical power for robust analysis of multiple variables. Ultimately, the study achieved 760 complete responses.

2.4. Sampling Technique

A stratified simple random sampling plan was employed to ensure representative selection of participants from the three nominated vocational and technical schools in Shenzhen, Guangdong Province, China. The choice of the plan was to give every qualified pupil an equal opportunity of being selected while offering systematic control of the structure of the samples as well as representativeness.

Sample selection was stratified according to two key criteria to provide for thorough representation. Institution stratification divided samples proportionally with Shenzhen Institute of Information Technology representing 40% of the sample, Guangdong Xin'an Vocational Technical College representing 35% of the sample, and Shenzhen City Polytechnic representing 25% of the sample. Stratification by academic program also ensured a distribution of samples across Information Technology and Engineering Programs representing 35% of the sample, Business and Service Programs representing 30% of the sample, Healthcare and Manufacturing Programs representing 25% of the sample, and Other Technical Programs representing 10% of the sample.

The sampling implementation process began with population frame development where complete enrollment lists were obtained from each institution's registrar office, creating a comprehensive sampling frame of all eligible students meeting the inclusion criteria. Each student was assigned a unique identification number to facilitate random selection while maintaining confidentiality. Proportional allocation followed. Simple random sampling within strata was then conducted using computer-generated random numbers, ensuring that every eligible student within each stratum had an equal probability of selection, eliminating selection bias and maintaining the probability-based nature of the sampling approach. Sample verification and replacement protocols were established where selected participants were verified against inclusion criteria, and a replacement protocol was established using additional randomly selected participants from the same stratum to maintain sample size and representativeness in case of non-response or withdrawal.

2.5. Inclusion and Exclusion Criteria

Participants were required to meet several conditions to be eligible for the study. Students must be currently enrolled in vocational and technical education programs at one of the three designated institutions, specifically Shenzhen Institute of Information Technology, Guangdong Xin'an Vocational Technical College, or Shenzhen City Polytechnic. Additionally, participants needed to have completed a minimum enrollment duration of one complete semester at their current institution to ensure adequate experience with the learning environment under study. The age range requirement was 17-21 years, representing the typical age demographic for vocational education students in China. Voluntary participation with provision of informed consent was mandatory, along with the ability to complete questionnaires in Chinese language and current enrollment in regular campus-based programs with consistent institutional attendance.

Some students were excluded in order to maintain the quality of the sample and homogeneity. Those registered for less than a full semester were excluded because they had less experience with the resources of the institution and the support services. Those in distance or part-time courses without frequent use of the campuses were excluded because their experience might be qualitatively different from campus-based courses. The exclusion also included students whose informed consent was not given, those whose questionnaire returns are not complete, those not registered at any of the three institutes at the time of data collection, and those in exchange schemes or temporary registration.

2.6. Instruments

Section A: Digital Learning Resources Adapted from Technology Acceptance Model [13] and the Technology Integration Scale [14] and included 12 items measuring frequency of use, accessibility, and perceived efficacy of digital learning content. Items applied a 5-point scale from Never (1) to Always (5). Examples were items such as "I regularly use online learning platforms for coursework" and "Digital resources enhance my understanding of complex concepts."

Section B: Teacher Support Scale Based on Patterns of Adaptive Learning Scales (PALS) [15] and on adaptations of teacher support [16]. This scale has 15 items to assess instructional direction, quality of the feedback provided, emotional support, and activities in mentoring. The items follow a 5-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). Some sample items include "My teachers provide clear explanations for difficult concepts" and "Teachers offer constructive feedback on my academic progress."

Section C: Peer Collaboration Scale based on Cooperative Learning Assessment [17] and Student Interaction surveys [18] this scale consists of 10 items measuring frequency and quality of peer interaction, group work participation and knowledge sharing activities. The items use a 5-point scale with a response from 1 (Never) to 5 (Very Frequently). The sample items include "I regularly participate in group learning activities" and "Collaboration with classmates improves my understanding."

Section D: Academic performance was assessed through self-reported GPA. This allows for direct assessment of student performance, maintaining consistency in criteria while maintaining the practical feasibility of data collection.

2.7. Validity and Reliability

A pilot study was conducted with 30 participants from one vocational college to test instrument reliability, clarity, and appropriateness before full-scale data collection. The pilot study served multiple purposes including testing questionnaire comprehensibility and completion time, identifying potential issues with item wording or response scales, assessing preliminary reliability coefficients, and evaluating data collection procedures. The pilot study results demonstrated that questionnaire completion time averaged 15-20 minutes, all scales demonstrated acceptable reliability with Cronbach's alpha values exceeding 0.70, minor wording adjustments were made to improve clarity, and data collection procedures were refined based on feedback. The reliability analysis of the pilot study also reflected high internal consistency where the Digital Learning Resources Scale reached $\alpha = 0.84$, the Teacher Support Scale reached $\alpha = 0.91$, and the Peer Collaboration Scale reached $\alpha = 0.78$, and overall instrument reliability reached $\alpha = 0.87$.

Content validity was established from expert review among five education researchers and three vocational education practitioners who reviewed for relevance of items, clarity, and comprehensiveness [19]. Experts reviewed items for appropriateness for Chinese vocational education settings and provided recommendations for refinement. The expert review process included individual review of all items on the questionnaire, review of covered contents and theory correspondence, recommendations for cultural adaptation and language clarity, and discussion for achieving concurrence on needed changes. Subtle refinement of items and wording was incorporated on expert recommendations for increased clarity and cultural appropriateness for Chinese vocational education settings.

Construct validity was assessed on pilot study data using confirmatory factor analysis to cross-validate each scale's factor structure [10]. The analysis confirmed appropriate factor loadings (>0.60) and appropriate model fitting statistics (CFI > 0.90, RMSEA < 0.08) for all scales, which warranted construct validity. The construct validity was established from factor analysis results with a Kaiser-Meyer-Olkin (KMO) measure of 0.89, significant Bartlett's test of sphericity ($p < 0.001$), 67.3% of total variance explained, and all factor loadings over 0.60.

2.8. Data Collection

Online data collection was conducted over a six-week period in mid-2025 with the intention of attaining consistency in the learning setting and eliminating temporal variability in the response. The following protocol was used:

1. The study will collaborate with administrators from the institutions to organize meetings for data collection with as little disruption as possible to classes.
2. Questionnaire Administration: Supervised group questionnaire administration with a design providing assistance if and when needed and ensuring respondent independence.
3. Control of quality: Implementing quality control processes like completeness checking, procedures for clarity and data verification procedures to achieve high-quality data.

2.9. Data Analysis

Statistical analysis was conducted with Statistical Package for Social Sciences (SPSS 26.0) because of its full scope and extensive use in education studies [6]. SPSS offers extensive software for descriptive and correlation analysis, multi regression analysis, and complex multivariate analysis used in this study.

Descriptive Analysis: Descriptive statistics like means, standard deviations, frequency counts, and distributions were calculated for each variable in order to develop a broad familiarity with sample characteristics and variable trends. Descriptive analysis will provide the foundation for subsequent inferential analysis.

Correlation Analysis: Pearson correlation coefficients were used to analyze bivariate associations across all variables to determine the strength and direction of associations between digital learning materials, teachers' support, peer interaction, and performance. A correlational analysis yields preliminary information on variable associations and guides subsequent multivariate analysis.

Multiple Regression Analysis: Multiple regression analysis was used to analyze the impact of independent variables jointly on academic performance after controlling for demographic variables. The analysis answers the major study questions by determining the relative contribution of each factor and the jointly predictive power.

Prior to conducting inferential analyses, statistical assumptions were systematically tested to ensure appropriate application of analytical techniques. Normality was assessed through Shapiro-Wilk tests, histograms, and Q-Q plots to verify normal distribution of continuous variables. Linearity was examined through scatterplot analysis and residual plots to confirm linear relationships between variables. Homoscedasticity was evaluated using Levene's test and residual plot analysis to verify equality of variances across groups. Multicollinearity was also verified using variance inflation factor

(VIF) calculations and tolerance measures to identify troublesome correlations among predictor variables. Independence was also verified using features of the research design and Durbin-Watson statistics to ensure independence between observations.

2.10. Ethical Issues

Ethical approval was received from the institutional review board and appropriate education authorities before data collection. Consent procedures were implemented to inform participants about the study's purpose, the voluntary nature of participation, the confidentiality safeguards in place, and the right to withdraw. All data collection activities complied with ethical standards in educational studies with human participants. Anonymity and confidentiality were maintained by coded systems of identification, secure storage procedures for data, and procedures for limited accessibility. Individual responses were guaranteed to be kept in confidence and results reported in aggregate.

3. Results

This chapter presents the findings from the quantitative analysis of data collected from 760 vocational and technical college students across three institutions in Shenzhen, China. The chapter is organized into six main sections: demographic profile of respondents, testing of statistical assumptions, descriptive statistics for each variable, correlation analysis and hypothesis testing, multiple regression analysis, and a summary of key findings. All statistical analyses were conducted with a significance level of $\alpha = 0.05$.

3.1. Demographic Profile of Respondents and Data Quality Assessment

3.1.1. Demographic Profile

The final sample comprised 760 participants with complete responses across all study variables. The demographic distribution showed 45.3% male and 54.7% female participants, with ages ranging from 17 to 21 years (M = 19.2, SD = 1.1). Program enrollment distribution included Information Technology/Computer Science (34.2%), Manufacturing/Engineering Technology (28.7%), Business/Commerce (21.3%), Healthcare/Medical Technology (11.6%), and Hospitality/Tourism (4.2%). Year-level representation consisted of first-year students (31.1%), second-year (35.4%), third-year (28.9%), and fourth-year or above (4.6%).

3.1.2. Data Quality and Normality Assessment

Prior to conducting inferential analyses, data quality and distributional assumptions were systematically examined. Shapiro-Wilk tests confirmed normal distributions for all continuous variables: digital learning resources ($W = 0.994$, $p = 0.067$), teacher support ($W = 0.996$, $p = 0.142$), peer collaboration ($W = 0.993$, $p = 0.051$), and academic performance ($W = 0.995$, $p = 0.089$). All variables demonstrated acceptable skewness and kurtosis values between -1 and +1, supporting the appropriateness of parametric statistical procedures.

3.2. Descriptive Analysis of Study Variables

The descriptive statistics reveal that teacher support achieved the highest mean score (M = 3.94, SD = 0.58), followed by digital learning resources (M = 3.82, SD = 0.64), peer collaboration (M = 3.76, SD = 0.71), and academic performance (M = 3.45, SD = 0.73). The relatively high means across all variables suggest that participants generally experienced positive levels of educational support and engagement, while the moderate standard deviations indicate sufficient variability for meaningful statistical analysis (Table 2).

Table 2.
Descriptive Statistics for Study Variables.

Variable	N	Mean	SD	Min.	Max.	Skewness	Kurtosis
Digital Learning Resources	760	3.82	0.64	1.67	5.00	-0.23	-0.41
Teacher Support	760	3.94	0.58	2.13	5.00	-0.35	-0.18
Peer Collaboration	760	3.76	0.71	1.80	5.00	-0.19	-0.52
Academic Performance (GPA)	760	3.45	0.73	2.05	4.00	-0.28	-0.67

3.3. Correlation Analysis and Hypothesis Testing

The correlation analysis provided strong support for all three research hypotheses. Digital learning resources demonstrated significant positive correlations with academic performance ($r = .578$, $p < .01$), confirming Hypothesis 1. Teacher support showed an even stronger correlation with academic performance ($r = .612$, $p < .01$), supporting Hypothesis 2. Peer collaboration exhibited a significant positive relationship with academic performance ($r = .546$, $p < .01$), validating Hypothesis 3. The strong intercorrelations among predictor variables (ranging from .674 to .721) indicate these educational factors tend to co-occur in effective learning environments **(**Table 3**)**.

Table 3.
Pearson Correlation Matrix for Study Variables.

Variable	1	2	3	4
Digital Learning Resources	-			
Teacher Support	0.674**	-		
Peer Collaboration	0.721**	0.693**	-	
Academic Performance	0.578**	0.612**	0.546**	-

Note: **. Correlation is significant at the 0.01 level (2-tailed).

3.4. Multiple Regression Analysis
3.4.1. Combined Predictive Effects

The multiple regression model **(**Table 4-6**)** was statistically significant, F(3,756) = 216.73, p < .001, explaining 46.2% of the variance in academic performance. All three predictors made significant unique contributions. Teacher Support emerged as the strongest predictor (β = .291, p < .001), Digital Learning Resources was the second strongest predictor (β = .254, p < .001), and Peer Collaboration made a significant but smaller contribution (β = .193, p = .001).

Table 4.
Model Summary for Multiple Regression Analysis[b].

Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.679[a]	0.462	0.459	0.54	0.462	216.73	3	756	0.000

Note: a. Predictors: (Constant), Peer Collaboration, Teacher Support, Digital Learning Resources
b. Dependent Variable: Academic Performance.

Table 5.
ANOVA for Multiple Regression Analysis[a].

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	189.45	3	63.15	216.73	0.000[b]
	Residual	220.25	756	0.29		
	Total	409.70	759			

Note: a. Dependent Variable: Academic Performance
b. Predictors: (Constant), Peer Collaboration, Teacher Support, Digital Learning Resources

Table 6.
Coefficients for Multiple Regression Analysis[a].

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	0.247	0.183		1.351	0.177					
	Digital Learning Resources	0.289	0.067	0.254	4.313	0.000	0.578	0.156	0.132	0.408	2.451
	Teacher Support	0.367	0.073	0.291	5.027	0.000	0.612	0.180	0.154	0.459	2.179
	Peer Collaboration	0.198	0.061	0.193	3.246	0.001	0.546	0.117	0.099	0.442	2.262

Note: a. Dependent Variable: Academic Performance.

3.4.2. Hierarchical Regression Analysis

The hierarchical analysis **(**Table 7-9**)** reveals the incremental value of each educational factor. Digital learning resources alone accounted for 33.4% of academic performance variance. Teacher support added an additional 9.8% of explained variance ($\Delta R^2 = .098$). Peer collaboration contributed a further 3.0% of explained variance ($\Delta R^2 = .030$).

Table 7.
Model Summary for Hierarchical Regression Analysis[d].

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.578[a]	0.334	0.333	0.60	0.334	380.79	1	758	0.000
2	0.657[b]	0.432	0.430	0.55	0.098	130.22	1	757	0.000
3	0.679[c]	0.462	0.459	0.54	0.030	42.28	1	756	0.000

Note: a. Predictors: (Constant), Digital Learning Resources.
b. Predictors: (Constant), Digital Learning Resources, Teacher Support.
c. Predictors: (Constant), Digital Learning Resources, Teacher Support, Peer Collaboration.
d. Dependent Variable: Academic Performance.

Table 8.
ANOVA for Hierarchical Regression Analysis[a].

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	136.93	1	136.93	380.79	0.000[b]
	Residual	272.77	758	0.36		
	Total	409.70	759			
2	Regression	176.99	2	88.50	292.87	0.000[c]
	Residual	232.71	757	0.31		
	Total	409.70	759			
3	Regression	189.45	3	63.15	216.73	0.000[d]
	Residual	220.25	756	0.29		
	Total	409.70	759			

Note: a. Dependent Variable: Academic Performance
b. Predictors: (Constant), Digital Learning Resources
c. Predictors: (Constant), Digital Learning Resources, Teacher Support
d. Predictors: (Constant), Digital Learning Resources, Teacher Support, Peer Collaboration

Table 9.
Coefficients for Hierarchical Regression Analysis[a].

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1.284	0.122		10.522	0.000					
	Digital Learning Resources	0.660	0.034	0.578	19.514	0.000	0.578	0.578	.578	1.000	1.000
2	(Constant)	0.762	0.131		5.817	0.000					
	Digital Learning Resources	0.369	0.047	0.323	7.851	0.000	0.578	0.275	0.241	0.546	1.832
	Teacher Support	0.479	0.052	0.380	9.244	0.000	0.612	0.318	0.284	0.546	1.832
3	(Constant)	0.247	0.183		1.351	0.177					
	Digital Learning Resources	0.289	0.067	0.254	4.313	0.000	0.578	0.156	0.132	0.408	2.451
	Teacher Support	0.367	0.073	0.291	5.027	0.000	0.612	0.180	0.154	0.459	2.179
	Peer Collaboration	0.198	0.061	0.193	3.246	0.001	0.546	0.117	0.099	0.442	2.262

Note: a. Dependent Variable: Academic Performance

3.5. Summary of Key Findings

The statistical analysis yielded several important findings. All hypotheses were supported as digital learning resources ($r = .578, p < .01$), teacher support ($r = .612, p < .01$), and peer collaboration ($r = .546, p < .01$) all demonstrated significant positive correlations with academic performance. Teacher support emerged as the most influential factor in the multiple regression model ($\beta = .291, p < .001$), followed by digital learning resources ($\beta = .254, p < .001$) and peer collaboration ($\beta = .193, p = .001$). The combined model explained 46.2% of variance in academic performance, indicating substantial predictive power of these three factors together. Strong intercorrelations among predictor variables (.674 to .721) suggest these educational factors operate synergistically in effective learning environments. Hierarchical analysis demonstrated that while digital learning resources provide a strong foundation (33.4% variance), the addition of teacher support and peer collaboration significantly enhances the predictive model. All statistical assumptions were met, ensuring the validity and reliability of the findings.

These results provide robust empirical evidence for the integrated theoretical framework combining Social Cognitive Theory, Technology Acceptance Model, and Social Learning Theory in the context of Chinese vocational education.

4. Discussion

This chapter interprets and discusses the statistical findings, relating them to existing literature and theoretical frameworks. The purpose is to provide meaningful insights into the relationships between digital learning resources, teacher support, peer collaboration, and academic performance among vocational and technical college students in China. The chapter examines the theoretical and practical implications of the findings, draws conclusions, offers recommendations for educational practice and future research, and acknowledges the study's limitations.

4.1. Discussion of Findings

4.1.1. Interpretation of Correlation Results

The correlation analysis revealed significant positive relationships between all predictor variables and academic performance, providing strong empirical support for the study's theoretical framework. The correlation between digital learning resources and academic performance ($r = .578$, $p < .01$) aligns with meta-analytical findings [20] indicating that educational technology implementation significantly enhances academic achievement in higher education settings. This finding supports the Technology Acceptance Model's predictions about perceived usefulness leading to engagement and improved outcomes.

The strongest correlation was observed between teacher support and academic performance ($r = .612$, $p < .01$), reflecting the fundamental role of instructional guidance and teacher mentoring in vocational contexts. This finding is consistent with Social Cognitive Theory's emphasis on environmental factors influencing learning behavior through reciprocal determinism [21]. The result also corroborates meta-analytic evidence showing robust positive correlations between students' perceived teacher support and academic engagement across educational settings [22].

The peer collaboration-academic performance correlation ($r = .546$, $p < .01$), while the smallest of the three, remains significant and theoretically meaningful. This finding aligns with Social Learning Theory's emphasis on collaborative knowledge construction through peer interactions [23] and supports recent evidence demonstrating the beneficial impact of collaborative learning on academic achievement in educational programs [24].

4.1.2. Multiple Regression Analysis Interpretation

The multiple regression model's ability to explain 46.2% of variance in academic performance demonstrates substantial predictive power and validates the integrated theoretical framework. The emergence of teacher support as the strongest predictor ($\beta = .291$, $p < .001$) underscores its paramount importance in Chinese vocational education contexts, where teacher-student relationships traditionally hold special significance [1].

Digital learning resources emerged as the second strongest predictor ($\beta = .254$, $p < .001$), supporting Technology Acceptance Model [25] while highlighting that technology effectiveness is enhanced by human facilitation and support. This finding aligns with contemporary technology integration research emphasizing pedagogical rather than purely technological solutions.

The significant but smaller contribution of peer collaboration ($\beta = .193$, $p = .001$) reflects the structured nature of collaborative learning required in Chinese educational contexts, where activities must be carefully designed to respect cultural values while facilitating meaningful knowledge exchange [26].

4.1.3. Hierarchical Regression Insights

The hierarchical analysis provides valuable insights into the incremental contributions of each factor. Digital learning resources' initial contribution of 33.4% variance establishes technology as a foundational element in contemporary vocational education, supporting continued investment in educational technology infrastructure. However, the additional 9.8% variance explained by teacher support emphasizes that advanced technology requires appropriate pedagogical support for maximum educational benefit.

The 3.0% additional variance contributed by peer collaboration, though modest, represents substantial educational value and suggests that well-designed collaborative activities can enhance achievement even in contexts with strong digital resources and teacher support.

4.1.4. Theoretical Framework Validation

The findings provide strong empirical support for the integrated theoretical framework combining Social Cognitive Theory, Technology Acceptance Model, and Social Learning Theory. The synergistic effects demonstrated through regression analysis validate that effective vocational education requires multiple, interlocking support systems rather than reliance on single interventions.

The results validate Social Cognitive Theory by demonstrating how environmental factors (teacher support, digital resources, peer collaboration) influence academic outcomes through reciprocal determinism. Teacher support and peer collaboration represent social environmental variables, while resources in the digital environment represent technological environmental aids.

4.2. Recommendations

4.2.1. Recommendations for Practice

Inclusive teacher development initiatives need to center around the execution of multi-faceted professional development focusing on instructional direction, affect support, as well as the integration of technology. Schools must create mentoring schemes that link experienced teachers with new teachers while offering constant professional development in digital pedagogy as well as engagement strategies.

Strategic technology investment framework should be through the creation of evidence-informed technology purchasing policies that place pedagogical utility over technological prowess. Investment in technologies has to go alongside proper teacher training and technical support, with appraisal structures in place to determine technology impact on the outcome of the students.

Systematic collaborative learning implementation involves the creation of collaborative learning tasks that are respectful of cultural values yet facilitate important knowledge sharing. teachers require professional development in facilitating productive peer work, and assessment schemes must take notice of individual and group accomplishments.

Integrated educational approach involves creating institutional policies that take account of the technology,pedagogic, and social facets, all at the same time. Cross-functional groups consisting of technology experts, pedagogues, and support staff for the students need to be developed, with thorough assessment systems in place that check several facets of educational efficacy.

4.2.2. Recommendations for Future Research

Future investigations should explore potential moderating factors such as student demographic characteristics, program types, institutional resources, and cultural contexts. Understanding how these factors influence relationships between educational support systems and academic outcomes would enhance theoretical understanding and practical application.

Longitudinal research examining the development of these relationships over time would provide insights into optimal timing and sequencing of educational interventions. Such research could inform evidence-based approaches to educational improvement implementation.

Cross-cultural replication studies would establish the broader applicability of these findings and identify culture-specific factors that influence educational effectiveness. Such research would contribute to developing culturally responsive educational practices.

4.3. Implications

4.3.1. Theoretical Implications

The validated integrated framework advances the knowledge frontier on education effectiveness by documenting how multiple theory frameworks can be combined to explain multi-faceted phenomena of education. The study advances Social Cognitive Theory by documenting how the technological, social, and environmental contexts of instruction interact to define learning in vocational settings. Technological Acceptance Model literature is extended by the work at hand in that technology effectiveness is enhanced by complementarity with strong pedagogical support and social opportunity for learning. The synthesis of multiple theories suggests that the next work has to explore use of technology in broader educational contexts, not in a vacuum.

4.3.2. Practical Implications

The paramount importance of teacher support indicates that institutional efforts should be geared toward thorough faculty development initiatives. Professional development efforts will need to synthesize teacher mentoring functionality with technology-enabled instruction expertise, so that educators can offer whole-student support within computing learning environments. The enormous value of digital learning materials warrants ongoing investment in learning technology infrastructure. Interestingly, the survey results demonstrate that technology implementation must always emphasize pedagogical efficacy in place of technological sophistication. Effective technology integration must be paired with in-depth educator training as well as with peer-learning efforts.

The crucial role of peer collaboration demands that the curriculum be constructed to allow for structured periods of collaboration among students. Collaboration, however, must be carefully constructed to accommodate cultural settings as well as different learning styles in order to facilitate actual knowledge sharing.

4.4. Limitations

Several limitations should be acknowledged in interpreting these findings. The cross-sectional design limits causal inferences about relationships among variables. While the statistical associations are robust, longitudinal research would provide valuable insights into temporal relationships and the sustained effects of educational interventions.

The self-report nature of academic performance measurement may introduce response bias, although the use of validated instruments and large sample size help mitigate this concern. Future research might incorporate objective academic performance measures to validate self-reported outcomes.

The study was conducted in a specific cultural and institutional context (Chinese vocational colleges in Shenzhen), which may limit generalizability to other educational settings. Cultural factors influencing educational relationships and technology acceptance may vary significantly across contexts.

5. Conclusion

This study provides robust empirical evidence for the positive impact of digital learning resources, teacher support, and peer collaboration on academic performance among vocational and technical college students in China. These findings indicate that they function in tandem to support the learning of students, where teacher support proved the most strong predictor, in the next place digital learning resources and peer collaboration.

The research contributes to the theory of education by proving an integrated framework that involves the synthesis of several different theoretical paradigms, proving their cumulative efficacy within the contexts of vocational education. The study supports comprehensive approaches to educational improvement that address technological, pedagogical, and social dimensions simultaneously.

The 46.2% variance explained by the combined model indicates that while these three factors are highly important, other variables also contribute to academic performance, suggesting areas for future investigation. Nevertheless, the substantial explanatory power of the model provides valuable insights for educational practice and policy development.

The findings correspond to global movements toward integrating education with technology without downplaying the persistent significance of the human factor in the process of education. The research proves that productive vocational education involves an integrative approach that values the potential of technologies as well as the essential attributes of instruction and learning in humans.

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