



# An Empirical Study on the Influence of Vocational College Students' Critical Thinking Ability Under the Community of Inquiry Framework

Xuemei Cai<sup>1,2</sup>(✉) and Yan Ma<sup>1,2</sup>

<sup>1</sup> College of Computer and Information Science, Chongqing Normal University, Chongqing, China

959527576@qq.com

<sup>2</sup> Wisdom Education Research Institute, Chongqing Normal University, Chongqing, China

**Abstract.** Under the environment of online learning being fully implemented, vocational college students' participation in online learning is not high, their learning willingness is not strong, and their ability of independent learning and collaborative learning is weak. The data were obtained from freshmen in a vocational college in Chongqing. This study applies computer technology to education statistics. SPSS software was used to preprocess the data, and SmartPLS software was used to construct a theoretical model based on CoI framework. By analyzing the validity test and correlation test of the measurement model and structural equation model, the suitability of the model was verified. The results show that critical thinking is the mediating factor of CoI model. Vocational colleges need to pay attention to the improvement of students' sense of social presence in online learning courses, so as to improve students' critical thinking ability and strengthen intentional deep learning in inquiry community learning.

**Keywords:** Community of Inquiry Framework · Critical thinking · Higher vocational education · Online learning

## 1 Introduction

In the outline of The National Medium and Long Term Education Reform and Development Plan (2010–2020) and the Ten-year Development Plan for Education Informatization (2011–2020) issued by the state and other relevant policy documents on the development of education informatization, it has been mentioned that education informatization should be included in the overall strategy of national informatization development.

Higher vocational education is different from ordinary undergraduate education, its education focus is to train application-oriented talents, but many higher vocational colleges have the teaching mode of paying more attention to practice than theory, paying more attention to results than to process, so theoretical courses cannot get attention. Therefore, how to improve the critical thinking ability of vocational college students in online learning is of great significance to promote the quality of vocational college online teaching and the improvement of students' cognitive development.

© The Author(s) 2023

Z. Zhan et al. (Eds.): EIMSS 2022, AHCS 7, pp. 1203–1212, 2023.

[https://doi.org/10.2991/978-94-6463-024-4\\_124](https://doi.org/10.2991/978-94-6463-024-4_124)

## 2 Relevant Theoretical Basis and Application of Computer Technology

### 2.1 Theoretical Basis

#### 2.1.1 Community of Inquiry Framework

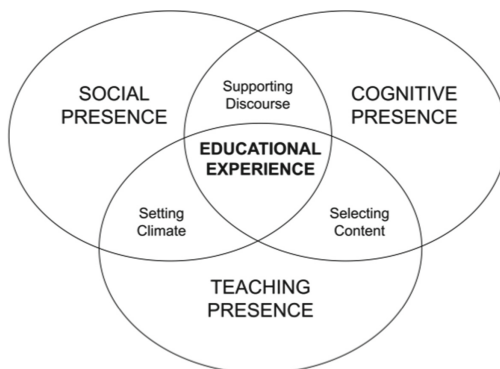
The inquiry community theory was generated by a humanities and social science project funded by the Canadian government from 1997 to 2001, “The characteristics and quality of text-based computer conference in education”. The core results of this research formed the inquiry community theory. Exploring community learning theory is also an important support for collaborative learning and advanced learning. Randy Garrison (D.R.Garrison) and Terry Anderson, a renowned Canadian scholar, created the Community of Inquiry Framework (CoI) [1]. Figure 1 is the theoretical framework for exploring community.

There are some guidelines to follow during the framework development process:

- (1) Create an atmosphere of open communication and trust in a planned way;
- (2) Cultivate critical reflection and dialogue in a planned way;
- (3) To build a common relationship between community members and community cohesion;
- (4) to establish the vitality of inquiry (purposeful inquiry);
- (5) To maintain mutual respect and mutual responsibility;
- (6) To maintain the inquiry and make it towards the solution of the problem;
- (7) Ensure that the evaluation is consistent with the expected process and results.

#### 2.1.2 Critical Thinking

Critical thinking can be thought of as the foundation upon which all decisions should be made and the skill that innovators in the 21st century are expected to possess [2]. For these reasons, most theoretical courses consider critical thinking as an important learning goal for students, discussed and thought about for many years in the education community,



**Fig. 1.** Community of Inquiry Framework.

and it is one of the eight educational goals proposed by policy makers and educators (Tempelaar, 2004). Maker education covers these areas, including critical thinking and problem solving skills. Yet despite these policy directives, teachers are still struggling with how to engage students in critical thinking activities, which students rarely use to solve complex, real-world problems [3].

## **2.2 Application of Computer Technology in Educational Statistics**

### **2.2.1 Big Data**

Big data requires special techniques to efficiently process large amounts of tolerant data over time. Technologies applicable to big data include massively parallel processing (MPP) databases, data mining, distributed file systems, distributed databases, cloud computing platforms, the Internet, and scalable storage systems.

### **2.2.2 Cloud Computing**

Cloud computing is a type of distributed computing. It refers to the use of a network “cloud” to break a huge data processing program into countless small programs. The results of these small programs are then processed and analyzed by a system of multiple servers and sent back to users. In the early days of cloud computing, simply put, it was simple distributed computing, dealing with task distribution and combining results. Therefore, cloud computing is also called grid computing. Through this technology, tens of thousands of data can be processed in a very short time (a few seconds), so as to achieve powerful network services.

### **2.2.3 Technical Summary**

In recent years, computer information technology with mobile Internet, big data, cloud computing, Internet of Things, 5G, artificial intelligence and block chain as the core has mushroomed and flourished and innovated with all walks of life. Informatization has become one of the important forces to promote social development. Education as one of the basic fields to promote social development, the informationization of education statistics is an inevitable historical trend of current social development. Statistics is an important tool for understanding phenomena, and educational statistics is one of the important means for people to understand and manage education.

## **3 Research Design**

### **3.1 The Research Methods**

Structural equation modeling (SEM) has been widely used in theoretical exploration and empirical research in many research disciplines (Bentler, 1980; Bagozzi and Yi, 1988). As an alternative to partial least-squares covariance based SEM (CBSEM), partial least-squares SEM (PLS-SEM) is a causal modeling method that focuses on maximizing explanatory variance dependent on potential structures, rather than constructing theoretical covariance matrices (Hair Jr et al., 2011). Partial least squares structural equation

modeling is a modern multivariate analysis technique, which has the ability to estimate theoretically established causal model. Using PLS-SEM in empirical studies can maximize data interpretation ability [4]. In recent years, more researchers choose to use PLS-SEM for the main advantages are as follows:

- (1) Compared with other methods, PLS requires less sample size and supports the analysis of small sample data;
- (2) PLS does not require input data of normal distribution; Support non-normal distribution of sample data;
- (3) PLS can process both reflecting and forming structures at the same time;
- (4) PLS is more suitable for theoretical development rather than theoretical testing;
- (5) PLS is prediction-oriented;
- (6) PLS can be applied to structural equation models with a large number of complex structures; Support research and analysis of complex models;
- (7) PLS supports exploratory structural model research.

### 3.2 Making Questionnaire

Through the research and analysis of previous literatures, this study referred to the English version of the Inquirycommunity Scale (Arbaugh et al., 2008) developed and compiled by Ben Arbaugh et al. (Arbaugh et al., 2008) and Karen Swan et al. (Swan et al., 2008) using exploratory factor analysis. In 2008, 24 questions were summarized based on the Chinese version of Professor LAN Guoshuai's Chinese processing, which was divided into four dimensions: teaching presence (TP), social presence (SP), cognitive presence (CP) and critical thinking (CT).

### 3.3 The Data Collection

The questionnaire star website was used to compile, distribute and collect questionnaires. A total of 300 questionnaires were distributed to a college in southwest China. 274 valid questionnaires were collected after excluding invalid ones, with a valid questionnaire recovery rate of 91.33%.

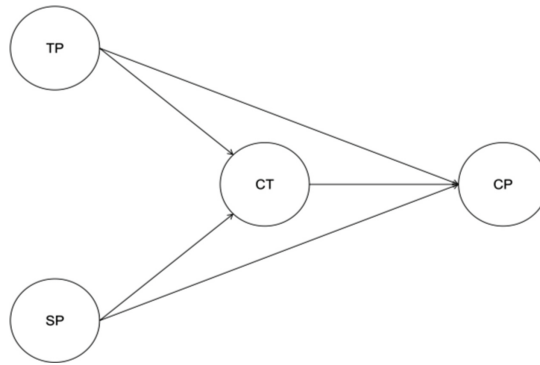
### 3.4 Data Analysis Software

This research belongs to the category of exploratory research, through the combination of inquiry community theory and critical thinking, integrated into an exploratory structural model. Therefore, statistical analysis software of SmartPLS 3.2.8 is used. In order to make the data processing more concise, SPSS software was used to preprocess the data after the questionnaire was recovered, which made the data import more convenient.

## 4 Data Analysis

SmartPLS software was used for modeling according to the hypothetical model, and the structural equation model as shown in Fig. 2 was obtained after data import.

In the process of data analysis, the observed variables T1 and S7 had no significant impact on their respective latent variables, so they were deleted and the analysis results were obtained as shown in Fig. 2.



**Fig. 2.** Analysis results of structural equation model.

**Table 1.** Reliability and validity coefficients of each dimension.

	Convergent validity	reliability	
	AVE	Composite Reliability	Cronbach's Alpha
CP	0.795	0.959	0.947
CT	0.820	0.948	0.926
SP	0.757	0.949	0.936
TP	0.885	0.979	0.974

## 4.1 Reflection Measurement Model Tests

### 4.1.1 Reliability and Validity Analysis

Cronbach's Alpha represents internal consistency, and Composite Reliability represents composition Reliability. When the two are greater than 0.8, the scale has high Reliability. Average Variance Extracted (AVE) greater than 0.5 indicates that the latent variable has reliability and convergence validity.

Table 1 shows that the reliability and validity of all dimensions are higher than the standard level, indicating that the reliability and convergence validity of the scale are ideal, and the internal consistency is high.

To test the Discriminant validity of the scale, the square root AVE value of the latent variable and the correlation coefficients of other latent variables are tested, as shown in Table 2.

Table 2 shows that the square root values of latent variable AVE are all greater than the correlation coefficients with other latent variables, indicating that the scale has high discriminant validity and does not have collinearity problems.

### 4.1.2 Path Analysis

In this study, path analysis was used to verify the correlation of various hypotheses in the model, and the significance of the path coefficients was assessed by Bootstrapping

**Table 2.** Test of AVE square root and correlation coefficient of other factors.

	Convergent validity	Discriminant validity			
	AVE	CP	CT	SP	TP
CP	0.795	<b>0.892</b>			
CT	0.820	0.789	<b>0.906</b>		
SP	0.757	0.884	0.702	<b>0.870</b>	
TP	0.885	0.887	0.689	0.829	<b>0.941</b>

Note: The diagonal bold characters are the square root values of each latent variable AVE, and the lower triangle is Pearson correlation.

**Table 3.** Coefficient of measurement ( $R^2$ )

	R Square	R Square Adjusted
CP	0.887	0.883
CT	0.531	0.519

(self-lifting sampling 5000 times, two-tailed test). Chin (1988) suggested that these values should be significant at the level of 0.050 and higher than 0.700. For exploratory research designs, a lower threshold is acceptable. Its significance can be tested by leading or overlapping cutting. The critical T Statistics values of the two-tailed test were 1.65, 1.96 and 2.58, and T Statistics > 1.96 represented all significance.

T Statistics are all greater than the standard value 1.96, and P values are all less than 0.05, indicating that the path has passed the significant test, and all hypothesis paths in the model are valid.

## 4.2 Structural Model Testing

### 4.2.1 Measure the Coefficient R Squared

After the measurement model is successful, the structural model can be analyzed. The first basic criterion for evaluating PLS structural equation models is the determinant coefficient  $R^2$  of each endogenous latent variable.  $R^2$  measures the relationship between the explanatory variance of a potential variable and its total variance [5]. These values should be high enough to give the model a minimum level of explanatory power. Chin (1998b) considered substantial values of about 0.670, medium mean values of about 0.333 and weak values of about 0.190 or lower.

Table 3 shows that among the two endogenous latent variables in the STRUCTURAL equation model, the explanatory ability of cognitive presence (CP) is large, while that of critical thinking (CT) is medium.

**Table 4.** Path coefficients

	Original Sample (O)	Standard Deviation (STDEV)	T Statistics	P Values
CT → CP	0.243	0.068	3.566	0.000
SP → CP	0.371	0.182	2.034	0.042
SP → CT	0.418	0.198	2.107	0.035
TP → CP	0.414	0.165	2.505	0.012
TP → CT	0.345	0.231	1.495	0.135

**Table 5.** Prediction correlation ( $Q^2$ )

	SSO	SSE	$Q^2 (=1-SSE/SSO)$
CP	486.000	159.417	0.672
CT	324.000	192.811	0.405
SP	486.000	486.000	
TP	486.000	486.000	

#### 4.2.2 Path Coefficients

Path coefficients between latent variables should be analyzed in terms of their algebraic sign, magnitude and significance.

Table 4 shows the influence of latent variables in the model. According to the P-value, it can be concluded that: In the model, critical thinking has a significant influence on cognitive presence; Social presence has significant influence on cognitive presence. Social presence has significant influence on critical thinking. Teaching presence has significant influence on cognitive presence. Since the P value of teaching presence on critical thinking is greater than 0.05, the influence is not significant.

#### 4.2.3 Prediction Correlation ( $Q^2$ )

Predictive correlation of structural models can be assessed by nonparametric Stone-Geisser tests (Geisser 1975; Stone 1974). Positive  $Q^2$  results confirm the predictive relevance of the model for a particular structure. Furthermore, the better the predicted correlation of the tested model, the greater the  $Q^2$  will be (Fornell and Cha 1994).

As shown in Table 5, the  $Q^2$  values of the two endogenous latent variables critical thinking and cognitive presence are both greater than 0, indicating a good predictive correlation.

## **5 Research Results and Discussion**

This study takes students of vocational colleges as the research object, and uses the method of empirical research to analyze the relationship between critical thinking in the inquiry community model, as well as the mutual influence among teaching existence, social existence, cognitive existence and critical thinking. The results:

### **5.1 The Development of Critical Thinking Can Greatly Predict the Cognitive Ability of Online Learning**

Critical thinking is the important path of advanced thinking, this study will be personal knowledge extraction, deep learning and interactive learning as the elements of critical thinking in exploring community model, structure model of formed an exploratory discovery teaching presence, social presence and critical thinking has a direct effect on cognitive sense. The results show that the most influential factor in teaching presence is whether teachers' teaching methods and behaviors strengthen the mutual influence and recognition among group members. In the sense of social presence, the most profound factors are the impression left by classmates in the course learning and the feelings of students when they communicate and interact.

Critical thinking is a process of reflection and dialogue on course knowledge learning, but the teaching effect of vocational college students' online learning is not good. In order to improve the cognitive absorption effect of vocational college students' online learning, it is necessary to pay attention to the improvement of critical thinking ability.

### **5.2 Develop the Mediating Effect of Critical Thinking to Construct the Inquiry Community Model**

As can be seen from the above data analysis, when critical thinking is combined into the inquiry community model as a mediator, it can have a significant impact on the model, which is positive, indicating that critical thinking or the inquiry community model is an important intermediary. What we should pay more attention to is the significant impact of social presence. According to social learning theory, the interaction between the environment and learners jointly affects learners' cognitive activities and explicit behaviors. Online learning environment is a complex hybrid learning environment, which is affected by various external factors. Inquiry communities focus on collaboration and dialogue, and pay more attention to learners' social interaction and knowledge construction. Social presence is an important factor affecting learners' interaction and team cohesion.

Compared with the cultivation of critical thinking in foreign countries, China is still lagging behind, and there are not many vocational colleges in China that can truly achieve systematic online education mode, and the importance of critical thinking cultivation is not enough. Therefore, vocational teachers should change their teaching mode from imparting knowledge to guiding learning and training thinking. The ascension of higher vocational students' critical thinking, and at the same time accompanied by exploring the effectiveness of learning communities, not just rely on the teachers' personal ability, but needs the support of the school leads, the critical thinking from the aspects of research to time level, make higher vocational colleges of online education curriculum characteristic, lead the new course in vocational education.



## 6 Conclusion

Compared with foreign countries for the cultivation of critical thinking, China is still behind, and there are not many higher vocational colleges and universities that truly systematize online education model, and the cultivation of critical thinking has not paid enough attention to it, so it is necessary for higher vocational teachers to change the teaching mode, from imparting knowledge to guiding learning and training thinking. The ascension of higher vocational students' critical thinking, and at the same time accompanied by agent Gui improve the effectiveness of learning community, not just rely on the teachers' personal ability, but needs the support of the school leads, the critical thinking from grind Gui level to time level, make higher vocational colleges of online education curriculum characteristic, lead the new course in vocational education.

**Acknowledgements.** This work was supported by Chongqing Education Science “14th Five-year plan” project (key project): Research on collaborative learning model construction and evaluation in intelligent education environment, Project no: 2021-GX-014; Chongqing Graduate Education and Teaching reform Research project (major project) : Teacher education discipline group relationship network and evaluation based on SNA, project no: YJG201009; Chongqing Graduate Education and Teaching reform Research Project (key project) “Long-term mechanism research and Practice of journalism and Communication Master case base construction under double-first-class background”, Project no: YJG202018; Graduate Scientific research innovation project of Chongqing Normal University -- Evaluation research on Artificial intelligence Course teaching in Middle school under intelligent Education Environment -- Take Chongqing as an example, Project no: YZH21012.

## References

1. Bandura A, McClelland DC (1977) Social learning theory. Prentice Hall, Englewood cliffs
2. Bandyopadhyay S, Szostek J (2018) Thinking critically about critical thinking: assessing critical thinking of business students using multiple measures. *J Educ Bus* 1–12
3. Rossi IV, Active learning tools improve the learning outcomes, scientific attitude, and critical thinking in higher education: experiences in an online course during the COVID-19 pandemic
4. Urbach N, Ahlemann F (2010) Structural equation modeling in information systems research using Partial Least Squares. *J Inf Technol Theo Appl* 11(2)
5. Zeng N, Liu Y, Gong P, et al. (2021) Do right PLS and do PLS right: a critical review of the application of PLS-SEM in construction management research. *Front Eng Manag* 8(3):14

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

