Factors Predicting Learning Performance in Flipped Classroom: A Survey Study Based on RCoI Framework

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Abstract: While previous studies have focused on the factors affecting *flipped learning performance*, few have examined these factors through the lens of the *Community of Inquiry* framework. This study investigated how *Teaching Presence*, *Social Presence*, *Cognitive Presence*, and *Emotional Presence*, as defined by a revised *Community of Inquiry* framework, predict flipped *learning performance*. The analysis employed correlation analysis and two-step hierarchical multiple regression methods and was conducted in a flipped Fundamentals of Computer Application course (N=503) at a private polytechnic university in China. The results revealed that *Teaching Presence*, *Social Presence*, *Cognitive Presence*, and *Emotional Presence* were all significantly correlated with *learning performance*. However, only *Teaching Presence*, *Cognitive Presence*, and *Emotional Presence* were significant predictors of flipped *learning performance*, while *Social Presence* was not. The findings offer both theoretical insights and practical implications for improving instructional design and classroom organization in flipped learning environments.

Keywords: Flipped Classroom, Learning Performance, Revised Community of Inquiry Framework

1. Introduction

The flipped classroom, a blended teaching approach, integrates in-class interactive collaboration with platform-based independent learning outside the classroom (Sari et al., 2025). Through the use of learning platforms, it effectively combines online learning with face-to-face instructional activities (Baig & Yadegaridehkordi, 2023). In this teaching model, students gain a preliminary understanding of key concepts through instructional videos before class, while in-class sessions are facilitated by teachers who guide students through a series of problem-solving activities to enhance instructional efficiency (Sointu et al., 2023). With the advantages of flexibility, timeliness, and interactivity (Adhami & Taghizadeh, 2024), the flipped classroom addresses several limitations of traditional teacher-centered pedagogy and has emerged as a widely adopted and effective teaching approach in higher education (Durrani et al., 2022; Le Roux & Nagel, 2018). For example, it increases in-class time, allows students to be more involved in classroom activities (Adhami & Taghizadeh, 2024), encourages students to be prepared for class, and reduces the cognitive load (Awidi & Paynter, 2019), which in turn enhances a positive learning experience and improves learner satisfaction and learning performance (Sointu et al., 2023). In addition, the flipped classroom has been widely adopted as a major and valuable pedagogical approach in global health emergencies (Divjak et al., 2022).

For flipped learning, empirical studies have shown mixed results. Bui et al. (2022) used a flipped classroom approach in an elective course for engineering students to develop their soft skills. The study revealed that students enrolled in the flipped course demonstrated significant improvements in self-management, self-control, and negotiation skills. Additionally, pre-class preparation was associated with higher levels of engagement in classroom learning activities (Bui et al., 2022). Samaila et al. (2024) further suggested that embedding quiz questions in pre-class recorded videos may increase completion rates of pre-class activities, student engagement, and learning success in the flipped classroom (Samaila & Al-Samarraie, 2024). By surveying students involved in flipped learning, some researchers have found that the flipped classroom pedagogy promotes deeper understanding and higher satisfaction compared to the traditional teaching model (Baig & Yadegaridehkordi, 2023; Shen & Chang, 2023; Strelan et al., 2020). On the other hand, some negative effects of flipped learning have also been found, such as students' lack of motivation to learn before class (Baig & Yadegaridehkordi, 2023), technical problems (Karaduman, 2025), lack of guidance for learning outside of class, and resistance to new forms of teaching (Akçayır & Akçayır, 2018). Accordingly, investigating the factors influencing learning performance in the flipped classroom holds substantial academic value and practical significance.

Several scholars have discussed the many factors that influence learning performance in flipped learning. Among them, learners' factors have an impact on learning performance, including motivation (Diaz-Carrion & Franco-Leal, 2022; Omarchevska et al., 2024; Strelan et al., 2015; Zainuddin, 2018), engagement (Mengesha et al., 2024), academic capability, epistemological beliefs (Strelan et al., 2015), self-regulation (Lee et al., 2022; Omarchevska et al., 2024; Tutal & Yazar, 2021), computer skills (Ballou & Huguenard, 2008; Karimian et al., 2024), and previous flipped experience (Tecedor & Perez, 2021). In terms of course factors, course structure (Samaila & Al-Samarraie, 2024), teaching methods (Zainuddin, 2018), and classroom activities have an impact on learning performance. Learning support factors, such as personalized video recommendations provided by learning management systems (Oliván-Blázquez et al., 2023), intelligent tutoring (Huang et al., 2023), timely feedback from instructors (Thai et al., 2017), infrastructural support, and uninterrupted internet access (Torres-Martín et al., 2022), play a crucial role in enhancing learning experiences. Additionally, factors influencing learning performance include the duration of flipped classroom implementation and class size (Tutal & Yazar, 2021).

The Community of Inquiry (CoI) framework is widely utilized for knowledge acquisition and problem-solving among community members, serving as a tool for analyzing and designing learning experience (Garrison et al., 1999). The CoI is the most established research framework for digital teaching and learning (Khodabandelou et al., 2024; Stenbom & Cleveland-Innes, 2024; Yue et al., 2025). Originally developed for online learning environments (Ariati et al., 2023), the CoI framework posits that learning is facilitated through the interaction of three key elements: *Teaching Presence* (TP), *Social Presence* (SP), and *Cognitive Presence* (CP) (Cleveland-Innes et al., 2024; Garrison et al., 1999). The core is to facilitate meaningful and deep learning among learners in online teaching and blended learning environments and to help learners engage in collaborative and constructive learning and critical reflective dialogue in order to cultivate critical thinking and higher-order thinking (Swan et al., 2009).

Research on CoI can be categorized into two types. One primarily examines the relationships among the three presences in online learning environments (Castellanos-Reyes, 2020; Shea & Bidjerano, 2009; Swan et al., 2009). The second type of research investigates the relationship between specific presences and learning performance in online learning environments (Guo et al., 2021; Joksimović et al., 2015; Yoon & Leem, 2021). A significant portion of this research has concentrated on online learning environments, whereas the CoI framework is generic (Garrison et al. 2010). It is also valid in constructivist learning environments such as the flipped classroom (Ariati et al., 2023). There is a lack of research on the relationship between the three presences and learning

performance in flipped classrooms. In addition, further expansion of the model's components is necessary to enhance its descriptive and explanatory power (Castellanos-Reyes, 2020). Anderson (2016) noted that emotion was inherently pervasive in learning, influencing each of the presences differently depending on the context. He further suggested that this emotional presence (EP) warrants deeper investigation. Additionally, there exists a gap in the literature regarding whether a revised Community of Inquiry (RCoI) framework incorporating EP can predict learning performance. The research questions addressed in this paper are as follows:

Question 1: Which factors of the RCoI are associated with learning performance in flipped learning?

Question 2: Which factors of the RCoI can predict learning performance in flipped learning?

To address these two research questions, this study will examine the relationship between the RCoI framework and flipped learning performance. Using correlation and regression analyses, the study will identify predictors of flipped learning performance based on the results of a questionnaire survey administered to 503 students engaged in flipped learning.

Although limited research has investigated the relationship between the four presences and flipped learning performance, particularly the connection between these presences and demographic variables such as computer skills and prior flipped experience, further studies are needed in this area. This study offers a novel perspective on the predictive role of the four presences in flipped learning performance. Depending on the extent of this predictive influence, the findings could provide both theoretical and practical insights for the rapidly evolving flipped classroom pedagogy worldwide.

2. Literature Review

2.1 Learning Performance

As an important variable in evaluating the quality and effectiveness of teaching and learning, learning performance is the ultimate goal of learning and education. It pertains to learners' capacity to apply newly acquired knowledge and understanding (Almasi et al., 2018), encompassing both the foundational knowledge and skills learned, as well as the ability to utilize them flexibly in varied contexts (Yin & Yuan 2022). In addition, it is an assessment of 'what has been learned' (Choy & Quek 2016). It can be measured by test scores (Yin & Yuan, 2022), self-reports (Tusyanah et al., 2023), GPA, letter equivalents or other indicators such as time spent learning (Kirschner & Karpinski, 2010). A common method used by researchers is the use of standardized test scores (e.g. from paper-and-pencil tests or high-stakes examinations) (Choy & Quek, 2016).

2.2 Revised Communities of Inquiry

The CoI framework is a collaborative constructivist process model comprising three core elements: TP, CP, and SP (Richardson et al., 2024). These elements interact and interdependently contribute to the theoretical framework for learners to effectively co-construct knowledge (Garrison et al., 2010). As research advanced, scholars concluded that the CoI framework required additional components to enhance its comprehensiveness, with one proposed addition being the inclusion of EP (Carroll et al., 2024; Cleveland-Innes & Campbell, 2012). Majeski et al. (2018) confirmed that emotion can be present as a stand-alone element of a community of inquiry. Exploring the CoI model offers a unique perspective, methodology, and set of tools for enhancing the learning experience in higher education, and it has been widely acknowledged by scholars worldwide (Yin & Yuan, 2022). Given the critical role of emotion in learning, this study incorporates the element of EP into the CoI framework to examine how the four components—TP, SP, CP, and EP—within the RCoI predict learning performance in the flipped classroom.

2.3 Teaching Presence

In the CoI framework, 'Teaching Presence (TP)' is defined as 'the design, facilitation, and direction of cognitive and social processes aimed at achieving learning outcomes that are both personally meaningful and educationally valuable' (Garrison et al., 2001). It encompasses a range of teaching and learning activities, both prior to and during the course, including course organization and design, as well as direct teaching and guidance (Das & J.V., 2024). Tusyanah et al. (2023) identified the factors influencing learning performance through a survey of 900 students. The findings revealed that TP, SP, and CP had a significantly positive impact on students' learning performance, with TP emerging as the most influential factor. The study of Yin et al. (2022) also showed that teaching presence has a significant impact on the prediction of learning performance (Yin & Yuan, 2022). Careful design of instructional organization, provision of more support, timely guidance (JiMei et al., 2024), clearly structured learning resources, and arrangement of learning activities during students' flipped learning are factors that are crucial for improving student satisfaction and enhancing the experience (Sointu et al., 2023).

2.4 Social Presence

Social presence (SP) is 'the ability of participants to identify with a community (e.g., a course of study), to communicate purposefully in a trusting environment, and to develop interpersonal relationships through the demonstration of personalities' (Das & J.V., 2024). Social presence focuses on important aspects that shape the social climate of a learning community, including emotions, open communication, and group cohesion (Das & J.V., 2024; Yue et al., 2025). Social presence is integral to maintaining course engagement and satisfaction and plays a significant role in the success or failure of learning (Nasir,

2020). Social presence is a key predictor of learning performance (Liu et al., 2009; Yoon & Leem, 2021). Higher levels of social presence are associated with increased collaboration and interaction among participants, thereby enhancing the likelihood of students achieving strong learning performance (Yin & Yuan, 2022). Huang et al. (2021) developed a four-dimensional model to examine factors influencing learning performance in the flipped classroom. The results indicated that SP had a more substantial impact on students' flipped learning performance (Huang et al., 2021). The flipped classroom creates a collaborative, social space that uses forums and group discussions to share learning experience and emotions, leading to deep learning (Le Roux &Nagel, 2018).

2.5 Cognitive Presence

Cognitive presence (CP) is 'the degree to which participants in any given configuration of a community of inquiry are able to construct meaning through sustained communication' (Garrison et al., 2001). Cognitive presence describes the stages of inquiry-based learning, including problem conceptualization, knowledge exploration, synthesis, and eventual solution (Das and J.V., 2024). Cognitive presence is the main driver of students' perceived learning, and students perceive that they learn more when they perceive sufficient cognitive presence (Choy & Quek, 2016). Galikyan and Admiraal (2019) explored the relationship between cognitive presence and learning performance in teacher education and showed that all three components of cognitive presence, namely, triggering event, integration, and resolution, were significantly related to final course grades. Guo et al. (2021) explored the relationship between cognitive presence and learning performance in online project-based learning (PjBL) among college students, and stepwise regression analyses showed that the exploratory component of students' cognitive presence was positively correlated with students' learning performance. Cognitive presence is a key factor influencing learning performance in the flipped classroom (Huang et al., 2021). The key to the flipped classroom lies in the design of student-centered learning activities, where students apply the knowledge they have gained from pre-class previews to form a solution to a problem and discuss, examine, and defend it until a consensus is reached, thus facilitating deep cognitive learning (Le Roux & Nagel, 2018).

2.6 Emotional presence

Cleveland-Innes and Campbell (2012) defined emotional presence (EP) as 'the outward expression of emotions, moods, and feelings by and between individuals in a community of inquiry in their relationships and interactions with learning technologies, course content, learners, and teachers'. Emotions are an important part of the learning process (Mahendar et al., 2025). When learners perceive a sense of safety and comfort in the classroom alongside a heightened awareness of emotional presence, it fosters group cohesion, enhances their ability to comprehend conflict, and ultimately supports deeper learning while establishing a

foundation for successful learning performance (Majeski et al., 2018). Jiang and Koo (2020) investigated the perceived emotional presence of non-traditional graduate students in online learning environments. The findings revealed that positive emotions were positively correlated with higher learning performance, while negative emotions were linked to poorer learning performance (Jiang & Koo, 2020). Tan et al. (2024) further demonstrated that emotional presence plays a significant role in enhancing collaborative learning performance. In flipped courses, videos are used by students as typical pre-course learning materials and video-based multimedia materials create positive emotions in students, which in turn increase learners' attention and interest (Chen & Sun, 2012).

3. Methodology

3.1 Participants

The invited participants were 543 students from the first year of a computer-related program. They were studying a FCA course at a polytechnic in China. The survey was conducted two weeks before the end of the study, and the researcher applied for and received ethical approval from the affiliated institution before data collection. Excluding five students who were absent and did not complete the questionnaire, a total of 538 responses were collected. Following initial data cleaning based on completion time, reverse-coded items, and attention-check questions (DeSimone et al., 2015), 503 valid responses were retained, yielding a validity rate of 92.6%.

The demographic characteristics of the participants are presented in Table 1. As shown, the proportion of female students (51.5%) is approximately equal to that of male students (48.5%). Additionally, the majority of participants (87.1%) are between 18 and 19 years of age.

Table 1: Selected Demographic Information (n=503)

		Frequency	Percent
Gender	Male	244	48.5
	Female	259	51.5
Age	17 and under	29	5.8
	18-19	438	87.1
	20-21	34	6.8
	21 and above	2	0.4

3.2 Context

The FCA course is a compulsory course for freshmen in computer-related disciplines at a private polytechnic in central China. The course used a flipped classroom teaching method to integrate students' learning experience into both face-to-face and online environments. Throughout the 8-week semester, students accessed online learning materials (OLMs) via the Chaoxing platform, a widely used learning management system in China, and engaged in self-directed learning

to deepen their understanding of the course content. The OLMs include instructional videos, courseware, quizzes and homework, which are posted by the instructor two weeks prior to the start of each course. During the online learning portion of the course, students participated in an online discussion forum and contacted the instructor through the discussion forum to ask questions related to the learning materials and assignments, and the instructor gave timely feedback. Once a week, students participated in a 2-hour face-to-face session, during which the instructor addressed challenges encountered during the pre-course study, designed learning activities, facilitated problem-solving through robocalls and thematic discussions, and engaged in direct communication with students to further clarify their understanding. Meanwhile, the teacher also arranged one activity for students to demonstrate their work, in which one student was randomly selected to demonstrate his/her work, and the teacher guided other groups of students to comment and discuss. Figure 1 shows the process of flipped learning in FCA.

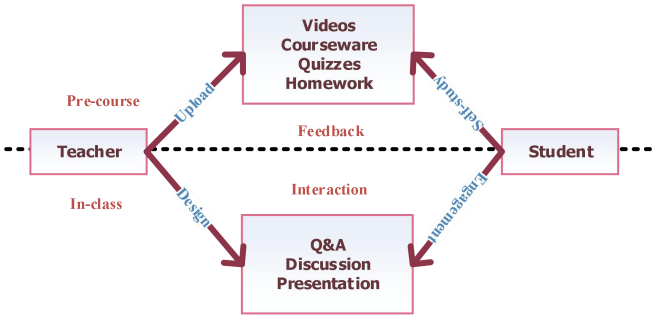

Figure 1 Structure of flipped classroom model

3.3 Measures

The study used the RCoI survey instrument to assess students' TP, SP, CP, and EP. The scale has four dimensions with a total of 40 items, with the TP, SP, and CP dimensions totaling 34 items developed by Arbaugh et al. (2008) and the EP dimension totaling six items developed by Cleveland-Innes and Campbell, (2012). Although the CoI survey instrument was designed for online learning environments, Ariati et al. (2023) validated the effectiveness of the CoI scale for use in a constructivist learning environment.

Since three items on the original CoI scale specifically referenced online discussions or online mediums, the flipped classroom focuses on online self-directed learning prior to class and participation in activities such as interaction, discussion, and collaboration during class. Therefore, the researcher revised these items appropriately. For example, replace 'communicating online or internet' with 'communicating with others.' The contexts of 'TP' and 'CP' were not changed in this study because the researcher agrees with Ariati et al. (2023) that the role of TP is the same regardless of whether the classroom context is

face-to-face or online. Meanwhile, the study retained the original CP and EP topics. Finalized items were reviewed by three education experts (professors or associate professors) to ensure content validity.

A 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used for all items. A pilot study was conducted to validate the instrument's efficacy in accurately assessing students' perceptions across various levels of the flipped classroom. A total of 401 participants were surveyed, and the collected data underwent item analysis and exploratory factor analysis (EFA) to assess the factor structure of the 40 items. During the item analysis, five items with non-significant score differences and two items with correlation coefficients below 0.4 were excluded (Li et al., 2021). The EFA results indicated that all 33 remaining items met the required criteria, with four factors extracted, explaining a cumulative variance of 59.95%. The confirmatory factor analysis (CFA) results demonstrated a good fit of the data to the model: $\chi^2/df = 1.250$, TLI = 0.978, CFI = 0.979, and RMSEA = 0.035. The reliability of the RCoI survey instrument was assessed using Cronbach's alpha, with TP having reliability of 0.918, SP 0.910, CP 0.879, and EP 0.916. Overall, the construct validity and reliability were deemed satisfactory (Nunnally, 1978).

3.4 Learning performance

Students' learning performance was derived from the student registry management system and measured through their final exams. The test questions were designed to align with the learning outcomes of the flipped lectures, ensuring content validity and the congruence of the questions with the course learning objectives. Furthermore, the questions were developed based on Bloom's Taxonomy of Educational Objectives, incorporating both lower-order cognitive skills (remember, understand, apply) and higher-order cognitive skills (analyze, evaluate). The test items were created by a senior faculty member and reviewed by other instructors to validate content validity and reliability, ensuring alignment with the course learning outcomes. To ensure the reliability of grading, the test papers for each class were graded by three lecturers on a rotating basis.

3.5 Control variables

With regard to control variables, student characteristics were included, as prior studies have indicated that certain demographic factors—such as gender, age, and academic level—can influence students' perceptions of a sense of community in online learning environments (Shea & Bidjerano, 2009). Additionally, research has demonstrated that computer skills and prior flipped learning experience may impact the pedagogical effectiveness of flipped courses, thereby influencing students' flipped learning performance (Ballou & Huguenard, 2008; Tecedor & Perez 2021). In this study, age distribution among participants was relatively homogeneous, and no significant correlation was found between gender and flipped learning performance. Consequently, only computer skills and flipped

learning experience were included as control variables for subsequent analyses.

4. Results

4.1 Descriptive statistics

Among the 503 students who participated in the survey, 20.3% reported having poor computer skills, while 79.7% demonstrated average proficiency. This suggests that the majority of students possessed sufficient computer skills to navigate the technological requirements of flipped learning. Additionally, 64% of the students had prior experience with flipped learning (as shown in Table 2).

Table 2: Descriptive statistics (n=503)

		Frequency	Percent
Computer skills	Poor	102	20.3
	General	171	34
	Good	176	35
	Very good	34	6.8
	Excellent	20	4
Flipped experience	YES	322	64
	NO	181	36

As shown in Table 3, the levels of students' presence in flipped learning were generally high across the four dimensions. Teaching Presence (TP) recorded the highest mean score (M = 3.81, SD = 0.62), while Emotional Presence (EP) had the lowest mean score (M = 3.52, SD = 1.16). Cognitive Presence (CP) and Social Presence (SP) followed, with mean scores of 3.79 (SD = 0.76) and 3.56 (SD = 0.64), respectively. Students' flipped learning performance was observed to be within the moderate to high range, with a mean score of 78.59 (SD = 11.98) out of a total of 100.

Table 3: Levels of presences and learning performance (n=503)

Characteristics	Number of Item	Mean	SD
TP	12	3.81	0.62
SP	6	3.56	0.64
CP	10	3.79	0.76
EP	5	3.52	1.16
LP	25	78.59	11.98

TP：Teaching presence, SP：Social presence, CP：Cognitive presence, EP：Emotional presence, LP： Learning performance

4.2 Correlation analysis

The questionnaire data satisfied the assumptions of normality (The Q- Q plot showed that the variable points lie roughly on a straight line, the absolute values of the skewness coefficients of the variables ranged from 0.49-1.39, and the absolute values of the kurtosis coefficients ranged from 0.41-2.74). Pearson correlation analysis (Table 4) revealed statistically significant positive correlations between flipped learning performance and TP (r = 0.524, $p< .001$), SP (r = 0.349,

p< .001), CP (r = 0.456, *p*< .001), EP (r = 0.495, *p*< .001). Additionally, computer skills (r = 0.190, *p*< .001), and flipped experience (r = 0.193, *p*< .001) were also positively associated with flipped learning performance.

Table 4: Result of Correlation analysis (n = 503)

		TP	SP	CP	EP	Computer skills	Flipped experience
LP	Pearson Correlation	.524**	.349**	.456**	.495**	.190**	.193**
	p	0.00	0.00	0.00	0.00	0.00	0.00

4.3 Regression model analysis

A two-step hierarchical multiple regression analysis was performed to examine the predictive validity of the four elements of the RCoI framework on flipped learning performance (Table 5). In the model, the VIF is between 1.14 and 1.51, which is below the critical value of 10, indicating that the model does not suffer from multicollinearity problems (Lai, 2021). In the first step, the F value was 14.97, which was significant at the 0.001 level, indicating that the model was meaningful. Both computer skills (β=1. 72, p<0.01) and flipped experience (β=3.73, *p*<0.01) significantly predicted the flipped learning performance, where the R value was 0.24, and the R^2 value was 0.06. In the second step, the prediction was improved by embedding the four presences in the model, where the F value was 56.11, *p*<0.001, the value of R was 0.64, the value of R^2 was 0.4, the variance explained by the independent variables to the dependent variable was 40%, TP (β=6.27, *p*<0.001), CP (β=3.47, *p*<0.001), and EP (β=2.97, *p*<0.001) all positively predicted the student's learning performance. While SP could not.

Table 5: Result of Hierarchical Multiple Regression

Variables	Model 1		Model 2		VIF
	β	t	β	t	
(Constant)	72.06	52.07	30.34	9.72	
Computer skills	1.72**	3.20	0.68	1.55	1.14
Flipped experience	3.73**	3.29	-1.14	1.24	1.13
TP	/	/	6.27***	7.74	1.47
SP	/	/	-0.44	-0.66	1.51
CP	/	/	3.47***	4.32	1.44
EP	/	/	2.97***	6.79	1.48
R	0.24		0.64		
R^2	0.06		0.4		/
ΔR^2	0.06		0.35		
F	14.97***		56.11***		

5. Discussion

This study aimed to investigate the predictive influence of student presence

on flipped learning performance, utilizing the revised components of the CoI framework. Descriptive statistical analyses indicated that students reported moderately high levels of agreement across all four elements of the RCoI framework, with the highest ratings for TP, followed by CP, SP, and EP. Similarly, students' flipped learning performance were also moderately high, suggesting that the four CoI elements of TP, SP, CP, and EP were effectively integrated into the flipped learning environment designed for the FCA course.

Correlation analysis revealed that TP, CP, SP, and EP were significantly associated with flipped learning performance. However, hierarchical multiple regression analysis indicated that while TP, CP, and EP were significant predictors of flipped learning performance, SP was not. TP has a crucial role in improving students' learning performance (Ke, 2010). This result is consistent with the studies of Yang and Cai (2023) and Tusyanah et al. (2023). In flipped FCA, teachers upload learning resources such as videos and quizzes through the Chaoxing platform, provide clear and detailed activity plans (e.g., time to complete assignments), and point out the focus of learning. Students can interact frequently with the teacher or classmates through the Chaoxing platform, valuing the opportunity to ask questions and get feedback in class, while flipped pedagogy provides students with a flexible way of learning in which they can watch the online lessons at their own convenient time and location. This design approach leads to an increased TP, which fosters more active student engagement with the learning material and promotes active participation in discussions, thereby directly enhancing learning efficiency and learning performance. (Ke, 2010).

SP was significantly associated with flipped learning performance, a result that closely matches the findings of previous research on teaching practices in online courses (Al-dheleai & Tasir 2020; Joksimović et al., 2015) as well as flipped classroom practices (Huang et al., 2021). The flipped classroom fosters a student-centered learning environment that enhances opportunities for active learning. In this approach, students are no longer passive recipients of teacher-led lectures; instead, their knowledge is actively constructed through interactions with instructors, peers, and various learning resources (Chen et al., 2014). However, SP does not significantly predict flipped learning performance. Lim and Richardson (2021) suggest that the inconsistent effects of SP on learning performance may be due to differences in the digital environments that the researchers may have used, the research tools, and the definitions and understandings of SP. This study suggests that this inconsistency may be due to sample differences. Students in private polytechnics are reluctant to initiate speech (Forhad et al., 2022). In flipped classrooms in private polytechnics, teachers should focus more on the use of sound teaching strategies (Lee & Ng 2010). When implementing collaboration and discussion interactions, teachers should create a safe learning atmosphere for students so that they are more willing and daring to actively participate in the

learning activities (E. Sointu et al., 2023).

CP significantly predicted learning performance, a result that supports the research of Almasi and Zhu (2020), Galikyan and Admiraal (2019), Cakiroglu (2019). In the flipped FAC course, students watch a video as an effective way to learn computer-related concepts and review the video if they forget or misunderstand a concept. After the video, students are required to complete a quiz or exercise, which reinforces their ability to apply concepts effectively. At the same time, classroom activities conducted by teachers, which were often brief, highly structured, and informative, such as thematic discussions and student presentations, and provided students with opportunities for discussion and practice with peers, as well as hands-on activities (e.g., creating presentations, e-portraits, and data manipulation), improved students' comprehension and attention.

Many studies have pointed out that emotions are important for learning and also affect learning performance (Dong & Gedvilienė, 2025; Van der Veer & Valsiner, 1994). EP in this study significantly predicted flipped learning performance. Emotions play an important role in cognitive learning (Guo & Wang, 2025), and performance in cognitive activities can be adversely affected by negative emotions but enhanced by positive emotions (Izard et al., 1984). Students' emotions are related to their cognitive, emotional and social engagement (Guo & Wang, 2025), motivation, use of learning strategies, self-regulation, and learning performance (Pekrun et al., 2011). In the flipped FCA course, videos are used by students as typical pre-course learning materials and video-based multimedia materials create positive emotions in students, which in turn increase learners' attention and interest (Chen & Sun 2012). Meanwhile, flexible pedagogical approaches enabled students to re-watch or rewind video lectures and in-class topic discussions, increasing student engagement in learning (Gutiérrez-González et al., 2024; Jeong et al., 2016).

Another key finding of this study is that both computer skills and prior flipped experience were significantly associated with flipped learning performance. This result aligns with the findings of Tecedor and Perez (2021), Ballou and Huguenard (2008), and Sletten (2015). Perceived computer skills influenced student behaviour in the FCA course by inducing students' computer self-efficacy and commitment to learning, leading to deeper engagement in flipped learning and consequently better performance (Ballou & Huguenard, 2008). In addition, students with flipped experience may have a better understanding of the process of implementing flipped pedagogy (Tecedor & Perez, 2021) and be better able to self-regulate their learning. Therefore, it is recommended that teachers should provide training for students with limited computer skills prior to implementing the flipped classroom. This ensures that students possess the necessary computer competencies and are capable of utilizing computers and the Internet to complete pre-class tasks effectively (Alamri, 2019).

Further, before starting the implementation of the flipped classroom, teachers should introduce students to the advantages of the teaching model and provide detailed information to reduce students' resistance to adopting new teaching methods and adapt to the change in teaching methods as soon as possible (Vuong et al., 2018).

6. Conclusion

The following conclusions can be drawn from this study: all four presences were significantly associated with flipped learning performance. Specifically, TP, CP, and EP were found to positively predict flipped learning performance, while SP did not. In the future, during the teaching of flipped courses, it is important to ensure that the course instructional videos are short and concise (Guo et al., 2014), the teaching objectives are clear, the activities are clearly organized (Baig & Yadegaridehkordi, 2023), and that instructors should be able to not only teach the professional course knowledge, but also be able to create learning contexts, facilitate collaborative learning activities, and provide support for students with different learning needs (Sointu et al., 2019). In addition, positively influence the learning process by using appropriate pedagogical methods and teaching strategies, such as immediate feedback (Sointu et al., 2023), verbal praise (Vuong et al., 2018), to increase students' positive emotions and decrease students' negative emotions (Jeong et al., 2016). When implementing collaborative and discussion interactions in flipped teaching, teachers should create a safe learning atmosphere for students to be more willing and courageous to actively participate in learning activities, as well as create more communication opportunities for students, such as idea sharing, questioning, group presentations, debates, and role plays.

7. Limitations and Future Research

Additionally, this study has several limitations. While the sample size was adequate, the study population consisted solely of freshmen at a private polytechnic university in China. As such, the generalizability of the findings may be limited. Secondly, this study is a cross-sectional research design. There is limited ability to determine the causality between the four elements and the learning performance variables. The future research could consider student participation at other educational levels (e.g., primary and secondary), as well as geographic areas, to ensure that students at all educational levels benefit from the flipped classroom approach. A longitudinal research design was considered to cross-measure the long-term impact of the flipped model on students' learning experience and learning performance. Future research will also explore the mediating effects between the four core elements and learning performance to add depth to the study and explore the deeper mechanisms of the factors that influence learning performance.

Acknowledgments

This research was partially supported by the Education Department of Henan Province (NO.2022YB0461, NO.2022SYJXLX132) and the National Natural Science Foundation of China (NO. 62207009).

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