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Social, Cognitive, Teaching, and Technology Presence in Blended Inquiry Learning: A Higher Education Study

Bambang Riadi*
Universitas Lampung, INDONESIA

Muhammad Fuad
Universitas Lampung, INDONESIA

Dwi Yulianti
Universitas Lampung, INDONESIA

Rangga Firdaus
Universitas Lampung, INDONESIA

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Abstract

Blended Inquiry Learning (BIL), an approach integrating blended and inquiry-based methods, seeks to enhance higher-order thinking skills (HOTS), including analysis, evaluation, and creation. This study explores the impact of BIL by assessing the roles of social, cognitive, instructional, and technological presence. Employing quantitative methods, data were gathered using a 19-item Likert scale questionnaire and analyzed through Partial Least Squares (PLS) Regression, a structural equation modeling technique. Participants included 222 students from various departments enrolled in the Indonesian Language Education course at the University of Lampung. The findings indicate that all four presences significantly influence BIL effectiveness, with technological presence having the most substantial effect and social presence the least. The study further advocates for incorporating technological presence as a fundamental component in the Community of Inquiry (CoI) framework to enhance the integration of digital technologies in education. This revised framework enables educators to design learning experiences that align with the demands of the technological era, utilizing tools such as Learning Management Systems (LMS), computer-based simulations, and virtual collaboration platforms.

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INTRODUCTION

In today's digital era, technology integration in education is essential to improve the quality of learning (Aulia & Yuliani, 2023; Fitri et al., 2022). Technology provides access to diverse educational resources, allows learning to be adapted to student's paces and learning styles, and encourages collaboration between teachers and students in different locations (Moore & Miller, 2022). One effective method of integrating technology and traditional learning is blended learning (Nurulsari et al., 2023). Blended learning combines face-to-face and online learning, utilizing the advantages of both approaches to create a more interactive and flexible learning experience (Gherheş et al., 2021; Smith & Hill, 2019).

Flexible learning models have demonstrated an enhancement in student happiness and an improvement in learning management, especially in time management (Nkomo & Daniel, 2021; Turan et al., 2022). In this situation, students in flexible learning play a critical role in their learning as they are expected to possess self-learning skills. Moreover, these skills encompass the ability to collaborate and interact with others in an e-learning environment, in addition to the ability to time management (Aller & Tangonan, 2023; McGarry et al., 2015). Studies, however, also indicate that the flexibility of learning can boost students' motivation, which supports their better learning performance (Singh et al., 2023; Thai et al., 2020).

* **Corresponding author:**
Bambang Riadi, Universitas Lampung, INDONESIA. ✉ bambang.riadi@fkip.unila.ac.id

The development of this approach continues, one of which is Blended Inquiry Learning (BIL) (Riadi et al., 2024). This model represents an approach to blended learning based on the inquiry method, which encourages students to engage in active learning through questioning, exploration, and the independent development of conceptual understanding. This method is effective in boosting higher-order thinking skills (HOTS), particularly analysis, evaluation, and creation, which are critical in 21st–century education (Riadi et al., 2024; Wang & Li, 2024). This is consistent with prior studies showing that inquiry-based learning improves students' involvement and understanding of subjects (Ghani & Taylor, 2021), student motivation (Nikou & Economides, 2018), and interest in learning material interest (Gillies, 2023). Thus, combining these two methods has the potential to enhance students' learning outcomes and overall educational experiences significantly.

The Community of Inquiry (CoI) framework's Social Presence, Cognitive Presence, and Teaching Presence components are closely linked to the efficacy of blended and online learning (Garrison, 2019). In the context of online and blended learning, social presence encompasses the social and emotional components of learners and has three dimensions: affective expression, group cohesion, and open communication (Garrison, 2019). In online learning, social presence is a crucial component that influences learning outcomes, engagement, and satisfaction (Kim-Pham et al., 2023; Martin et al., 2022; Miao & Ma, 2022; Zhang et al., 2024). Online and blended learning experiences can be made more effective and fulfilling by comprehending and controlling the aspects of social presence. Strategies to enhance social presence and learning outcomes should be taken into account by instructors and course designers.

The degree of student participation in reflection and discussion is referred to as the cognitive presence (Yang & Lay, 2024), particularly in online courses that have four stages: trigger event, investigation, integration, and resolution (Garrison, 2019). Case-based discussions and online practice projects are two examples of instructional activities that exhibit these phases (Moore & Miller, 2022; Ozogul et al., 2022). Higher degrees of cognitive presence have been linked to improved academic achievement, according to studies (Almasi & Zhu, 2020). We extend the cognitive presence phases to exposure, team investigation, peer verification, communication, and closure within the framework of the BIL model (Riadi et al., 2024). This is done to encourage cognitive presence by allowing students to investigate, integrate, and apply new knowledge through continuous intellectual debates.

Designing and organizing, encouraging discussion, and providing direct instruction are three key aspects of teaching presence in online and blended learning environments (Garrison, 2019). Student engagement in behavioral, cognitive, and emotional learning are all significantly influenced by the teaching presence (Li & Wang, 2024; Wang, 2022). In addition, perceived learning satisfaction is moderately correlated with teaching presence (Anderson et al., 2019; Caskurlu et al., 2020). In the context of the BIL model, teaching presence is related to how a teacher designs learning using a learning management system to facilitate discussion and provide direct instruction to students. This helps create a more effective and efficient learning community.

Previous research has examined the impact of social, teaching, and cognitive presence in blended learning environments. Several studies highlight the importance of social and cognitive presence in online and blended learning. For example, research indicates that collaborative online learning through positive peer interactions not only enhances engagement, problem-solving skills, and knowledge construction but also strengthens students' sense of belonging (An et al., 2022; Vania et al., 2022). Additionally, Almasi & Zhu (2020) demonstrated that social, cognitive, and teaching presence are strongly correlated with student traits and academic performance in university blended learning programs. Research has also focused on blended learning in specific contexts, such as English language learning. Mahmood et al. (2024) and Wardhani (2022) Highlighted that blended learning strategies, combining face-to-face and online methods, positively impact ESL learners by enhancing their writing, listening, and speaking skills. However, while many studies have examined presence components in blended learning, none have explicitly explored the interactions between Social Presence, Cognitive Presence, Teaching Presence, and Technology Presence within a BIL framework. Thus, this study aims to fill the gap by analyzing the four elements' influence on BIL's effectiveness. This research is likely to bring new insights and significant contributions to the development of more adaptive and effective learning models in the

digital era, particularly in the context of inquiry-based learning that prioritizes active student participation.

METHOD

This study employs a quantitative methodology to analyze how one variable influences others, as outlined by (Creswell & Creswell, 2023). This study observed five variables: four independent variables (social presence, teaching presence, cognitive presence, and technology presence) and one dependent variable (effectiveness of Blended Inquiry Learning). This research was conducted at the University of Lampung with 222 students as participants. To obtain a diversity of academic backgrounds, participants were selected from several study programs, namely Mathematics, Informatics Engineering, International Relations, and Guidance and Counseling. Data collection was carried out using an online questionnaire created through Google Forms and given to students after learning activities using the Blended Inquiry Learning (BIL) model. This is an exciting step to ensure that student responses are not based on a reflective process but from direct experience in following learning with the BIL model so that the data obtained are perceptions, understandings, and authentic experiences during the learning process.

The dependent and independent variables are measured using an interval scale. Respondents were provided with a five-point Likert scale for quantitative analysis, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), to evaluate their responses for each variable. The questionnaire was newly developed for this study and validated by experts to ensure its accuracy and relevance. The questionnaire data were analyzed employing the Partial Least Square (PLS) method, utilizing Smart PLS software. This approach uses a non-parametric Structural Equation Modelling (SEM) technique to evaluate the research model. PLS is suitable for analyzing complex relationships between variables, especially when the sample size is limited (30-100 samples) and the data does not follow a specific distribution (Lin et al., 2020; Nie et al., 2023). In PLS, the independent variables affect the dependent variable through linear relationships extracted from the latent components. This allows analysis even when the sample size is small and the data is not normally distributed. Data analysis includes variable validity and reliability tests and inner and outer model analysis. The research procedures and instruments are presented in detail in Figure 1 and Table 1.

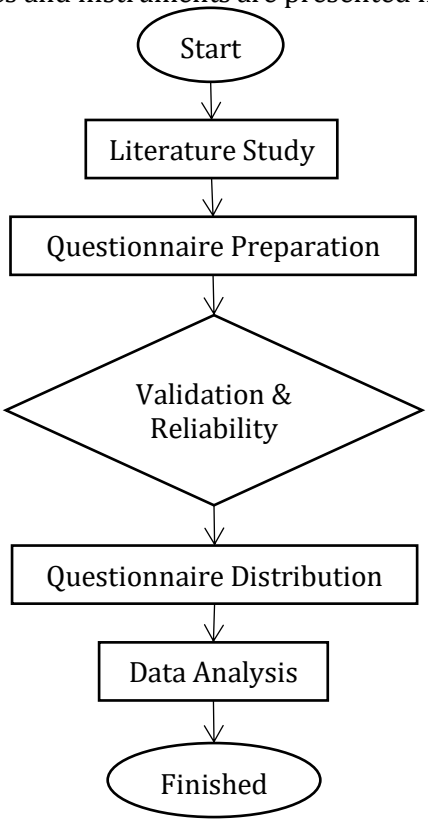

Figure 1. The Research Procedure Flowchart

Figure 1 illustrates the research process flow using a questionnaire starting from the Literature Study as the basis for preparing the questionnaire. After the Questionnaire Preparation stage, Validation and reliability are conducted to ensure the quality of the questionnaire. If not valid, the questionnaire is revised; if valid, the process continues to Questionnaire Distribution. The collected data is analyzed at the Data Analysis stage, and the research is completed at the Finished stage.

Table 1. The Research Instruments

No.	Variables	Indicators	Question
1	Social Presence	SP 1	I feel more confident in expressing my opinion during discussions in BIL class.
		SP 2	Group discussions help me feel more connected with my classmates
		SP 3	Interaction with classmates makes the learning process more enjoyable and effective.
2	Cognitive Presence	CP 1	The materials and activities provided at the exposure stage helped me recognize the key issues and led me to further explore the topics studied.
		CP 2	The discussions in the team at the investigation stage encouraged me to think critically and consider different perspectives on the learning topic.
		CP 3	The verification process with my teammates helped me evaluate my understanding in depth and identify gaps in the investigation results.
		CP 4	Sharing and discussing the results of the investigation with the group improved my understanding of the topic and reinforced the ideas I learnt.
		CP 5	The conclusion at the end of the lesson helped me integrate the understanding from the previous stages and apply the learning concepts to a broader context.
3	Teaching Presence	TP 1	The briefing from the lecturer really helped me understand the stages in the BIL model.
		TP 2	Lecturers encourage productive discussions that are relevant to the learning topic.
		TP 3	Lecturers are always available to provide guidance during the learning process.
4	Technology Presence	TIKP 1	Technology makes it easier for me to access relevant resources.
		TIKP 2	I feel more efficient in learning because of the technology used
		TIKP 3	Technical constraints are rare and do not interfere with my learning process.
5	Effectiveness of Blended Inquiry Learning	BIL 1	I feel that the BIL model makes me understand the subject matter more thoroughly.
		BIL 2	BIL encourages me to be more independent in managing my learning process.
		BIL 3	The BIL model helped me improve my critical thinking skills.
		BIL 4	BIL provides a richer and more meaningful learning experience compared to other learning models
		BIL 5	I feel that the BIL model is effective in improving my understanding of the topics learnt.

Table 1 contains the research instrument consisting of five main variables: Social Presence, Cognitive Presence, Teaching Presence, Technology Presence, and Effectiveness of Blended Inquiry Learning (BIL), with each variable having associated indicators and questions. Social Presence includes the interaction and connectedness between participants during the discussion. Cognitive Presence emphasizes understanding, critical thinking, and evaluation of learning concepts through the stages of BIL. Teaching Presence focuses on the lecturer's role in providing direction, supporting discussion, and providing guidance. Technology Presence evaluates the role of technology in facilitating access to materials, learning efficiency, and lack of technical barriers. Finally, the Effectiveness of BIL measures the effectiveness of the BIL model in improving understanding, independence, critical thinking skills, and a more meaningful learning experience.

RESULTS AND DISCUSSION

Research Findings

This study uses several variables with varying numbers of indicators, and to identify the most dominant indicators, validity and reliability testing is required by evaluating the outer and inner models. Indicator validity is measured using a loading factor, which is a value that represents the relationship between the question item score and the construct indicator score when measuring a construct (Afthanorhan et al., 2020). A loading factor value above 0.7 is considered valid. However, according to Hair et al. (2021), a minimum value of 0.3 is eligible, a value of 0.4 is more recommended, and a value above 0.5 is considered significant. In this study, the minimum loading factor limit used is 0.7, with the results of data analysis processed using Smart PLS 4.0 shown in Table 2.

Table 2. The Loading Factor Values

No.	Variables	Indicators	Outer loadings
1	Social Presence	SP 1	0.825
		SP 2	0.843
		SP 3	0.811
2	Cognitive Presence	CP 1	0.729
		CP 2	0.834
		CP 3	0.849
		CP 4	0.844
		CP 5	0.852
3	Teaching Presence	TP 1	0.846
		TP 2	0.858
		TP 3	0.875
4	Technology Presence	TIKP 1	0.858
		TIKP 2	0.848
		TIKP 3	0.843
5	Effectiveness of BIL	BIL 1	0.791
		BIL 2	0.761
		BIL 3	0.856
		BIL 4	0.747
		BIL 5	0.741

Table 2 shows the outer loadings for the five research variables: Social Presence, Cognitive Presence, Teaching Presence, Technology Presence, and Effectiveness of BIL. All indicators have loading factor values above 0.7, which indicates good convergent validity. These results confirm that all indicators are feasible to use in further analyses.

Next, discriminant validity is assessed using cross-loading values obtained from concept measurements. The cross-loading number quantifies the degree of association between the construct and its indicators and its correlation with indicators from other construct blocks. A measurement model has good discriminant validity when the correlation between the construct

and its indicators surpasses those of other construct blocks' indicators. Table 3 presents the findings of this study's discriminant validity assessment.

Table 3. The Cross-loading Values

Indicators	Social Presence	Cognitive Presence	Teaching Presence	Technology Presence	Effectiveness of BIL
SP 1	0.825	0.711	0.657	0.658	0.698
SP 2	0.843	0.725	0.670	0.700	0.724
SP 3	0.811	0.710	0.692	0.638	0.689
CP 1	0.648	0.729	0.617	0.626	0.640
CP 2	0.698	0.834	0.724	0.681	0.741
CP 3	0.728	0.849	0.711	0.675	0.739
CP 4	0.736	0.844	0.685	0.740	0.751
CP 5	0.747	0.852	0.783	0.705	0.792
TP 1	0.714	0.743	0.846	0.667	0.759
TP 2	0.717	0.756	0.858	0.664	0.767
TP 3	0.665	0.712	0.875	0.694	0.716
TIKP 1	0.689	0.693	0.706	0.858	0.724
TIKP 2	0.700	0.720	0.632	0.848	0.750
TIKP 3	0.664	0.712	0.663	0.843	0.730
BIL 1	0.681	0.702	0.735	0.666	0.791
BIL 2	0.655	0.688	0.663	0.640	0.761
BIL 3	0.678	0.742	0.689	0.766	0.856
BIL 4	0.698	0.683	0.592	0.630	0.747
BIL 5	0.613	0.667	0.712	0.667	0.741

Table 3 presents cross-loading values used to assess the discriminant validity of the measurement model. Discriminant validity can be confirmed if an indicator has a higher loading on its intended construct compared to other constructs (Afthanorhan et al., 2021). The highlighted (watermarked) data represent the highest loading values for each indicator on their corresponding constructs. This indicates that these indicators are strongly associated with the constructs being measured, demonstrating that they are valid measures.

The outer model is assessed by analyzing the reliability of constructs or latent variables through Cronbach's alpha and composite reliability score, where a score of 0.7 or higher indicates reliability. Additionally, the construct's credibility can be determined using the Average Variance Extracted (AVE) value, which should exceed 0.5. The results of the composite reliability analysis are detailed in Table 4.

Table 4. The Construct Reliability and Validity

Variables	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
Social Presence	0.768	0.866	0.683
Cognitive Presence	0.880	0.913	0.677
Teaching Presence	0.824	0.895	0.739
Technology Presence	0.807	0.886	0.722
Effectiveness of BIL	0.839	0.886	0.609

According to the Smart PLS output shown in Table 4, the reliability values of all constructs exceed 0.7 and 0.5. This indicates that each construct has a good level of reliability because the value has exceeded the specified minimum limit. Upon completion of testing the outer model, the inner model or structural model is then tested. Inner model evaluation is conducted by examining the dependent construct's r-square value (indicator reliability) and the t-statistic value of the path coefficient test. A higher r-square value indicates an improved capacity of the model to predict the study's variables. The path coefficient value indicates the significance level in hypothesis testing.

Table 5 presents the coefficient of determination (R^2), also known as the Determination Test, utilized to assess the degree to which the independent variables affect the dependent variable.

Table 5. R-square Value

Variables	R-square
Effectiveness of BIL	0.872

Table 5 demonstrates that social presence, teaching presence, cognitive presence, and technology presence account for 87.2% of the variability in the factors affecting the efficacy of Blended Inquiry Learning. The remaining 12.8% is affected by factors outside the scope of this study. The evaluation of the inner model or structural model, encompassing the r-square value, parameter coefficients, and t-statistics, is conducted to assess the hypothesis. The determination to accept or reject the hypothesis relies on significant values among constructs, t-statistics, p-values, and additional criteria. This study uses the Smart PLS (Partial Least Squares) software to evaluate the established hypotheses, using bootstrapping results as a benchmark. The evaluation is based on the T-statistic value exceeding 1.96, a p-value significance level of 0.05 (5%), and a positive beta coefficient. Table 6 delineates the analytical outcomes pertinent to the study's assumptions, whereas Figure 2 illustrates the findings of the proposed research model.

Table 6. The Path Coefficient Results

Variables	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
X1: Social Presence -> Y: Effectiveness of BIL	0.135	0.136	0.054	2.494	0.013
X2: Cognitive Presence -> Y: Effectiveness of BIL	0.289	0.288	0.066	4.385	0.000
X3: Teaching Presence -> Y: Effectiveness of BIL	0.281	0.278	0.058	4.855	0.000
X4: Technology Presence -> Y: Effectiveness of BIL	0.294	0.297	0.052	5.670	0.000

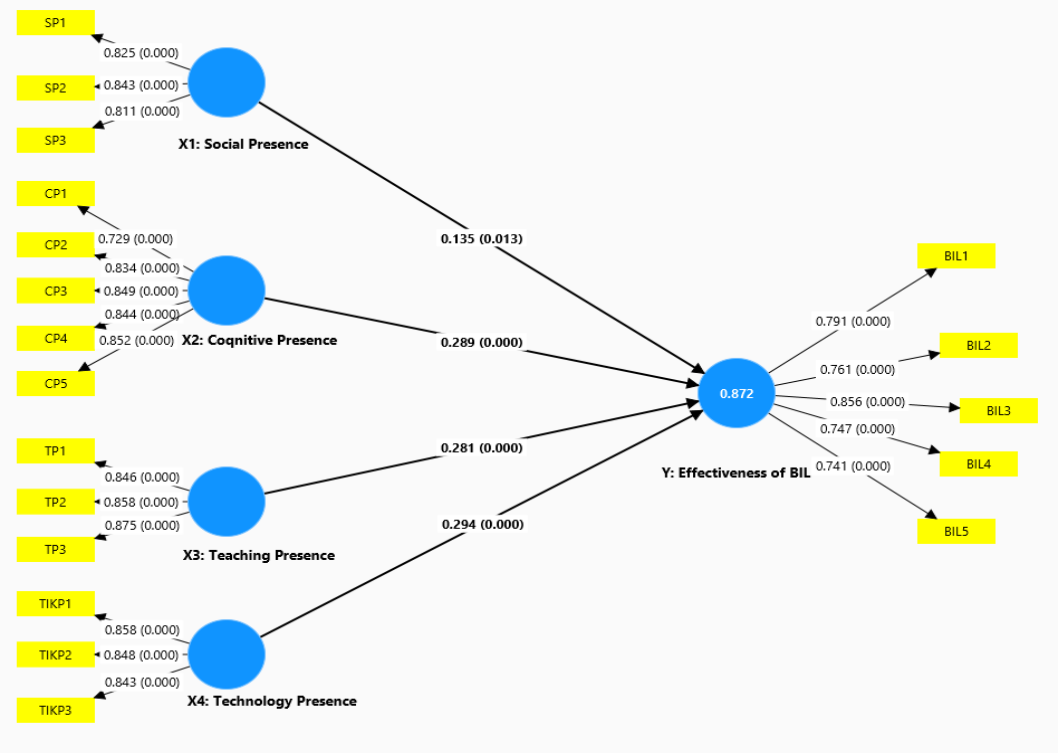

Figure 2. The result of The Research Model

Based on Table 6, the overall p-value shows a number smaller than 0.05. This indicates that all variables positively influence the effectiveness of online learning. Technology presence is the variable that gives the most significant influence (0,294), while the most minor influence comes from social presence (0,135).

Discussion

Blended Inquiry Learning involves four important components that enhance learning effectiveness, namely social presence, cognitive presence, teaching presence, and technology presence. Research shows that technology presence significantly influences learning effectiveness, while social presence tends to have a minor influence. Blended Inquiry Learning relies heavily on the technology presence to provide an engaging and supportive learning environment (Lam et al., 2022). The appropriate use of technology can improve the material's accessibility, facilitate communication, and enable students' collaboration. A study proved that blended learning can improve students' critical thinking skills through technology well integrated into the learning process (Ardianti et al., 2020; Saekawati & Nasrudin, 2021). Other studies have emphasized the importance of technology in providing students with greater flexibility in accessing information materials and collaborating in completing tasks, hence boosting their learning outcomes (Ernawati & Sari, 2022; Ningsih & Novita, 2022).

On the other hand, the teaching presence is the one who guides and facilitates the learning experience. Studies show that a strong teaching presence in blended learning contributes to the engagement of students and the establishment of cognitive presence (Cornelius et al., 2019; Martin et al., 2022). However, teaching presence is not limited to material delivery; management of constructive interactions and feedback is needed to foster meaningful learning (Kucuk & Richardson, 2019). In this context, teaching presence collaborates with technology to create a more effective learning experience. Another important element that contributes to the effectiveness of blended inquiry learning is cognitive presence, which refers to students' critical and reflective thinking processes. It has been shown in the literature that cognitive presence, such as which supports deep inquiry, is attained together with social presence and a well-implemented teaching presence (Huang & Lee, 2022). This means that cognitive presence is affected by social interaction and teaching (what teaching is effective), which helps improve student learning outcomes (Akyol & Garrison, 2019; Kim-Pham et al., 2023).

Although social presence is important in creating a sense of connectedness among students, the results of this study suggest that it has a smaller impact on learning effectiveness than other elements. Supporting this view, Martin et al. (2022) observed that social presence showed a weaker correlation with learning outcomes compared to teaching and cognitive presence. Similarly, Khodabandelou et al. (2023) found minimal variation in students' perceptions of social presence across different blended learning platforms, indicating its relatively limited influence. As a result, educators developing blended learning environments should focus on strengthening teaching and cognitive presence to optimize learning outcomes while ensuring sufficient social presence to foster student engagement and satisfaction (Dow et al., 2024). To improve social presence, Instructors must create an environment that supports open communication and group cohesion. This includes providing practical guidance and creating a sense of mutual support and understanding (Kim-Pham et al., 2023; Shehzad & Charles, 2023).

In designing effective blended learning, teachers need to ensure that these four elements (Social, Cognitive, Teaching, and Technology Presence) are integrated and mutually supportive. A strong social presence will facilitate student collaboration, an excellent cognitive presence will trigger critical thinking and deep understanding, an adequate teaching presence will provide guidance and structure, and a technological presence will ensure the smoothness and efficiency of the learning process. By paying attention to and optimizing each of these elements, the effectiveness of blended learning models, particularly Blended Inquiry Learning, can be well achieved, resulting in meaningful learning and improving students' critical thinking skills and learning independence.

Considering the critical role of technology in blended learning in this study, the Community of Inquiry (CoI) theory needs to add the Technology Presence element as an integral component to enhance learning effectiveness. CoI theory initially consisted of three main elements (Social,

Cognitive, and Teaching Presence) that focus on social, cognitive, and pedagogical aspects of creating an interactive and collaborative learning environment. However, in the current context of digital learning, technology plays a vital role in supporting, strengthening, and connecting the three elements. Technology positively impacts collaborative learning by encouraging learning methods that involve active engagement, discussion, repetition of material, increased interaction, cooperation, access to educational resources, and knowledge acquisition, thus creating a more optimized, dynamic, and interactive learning environment while helping students hone their ability to think deeply and complexly (Rintaningrum, 2024; Souza et al., 2024; Vali, 2023). Therefore, this research offers an improved CoI theory, as illustrated.

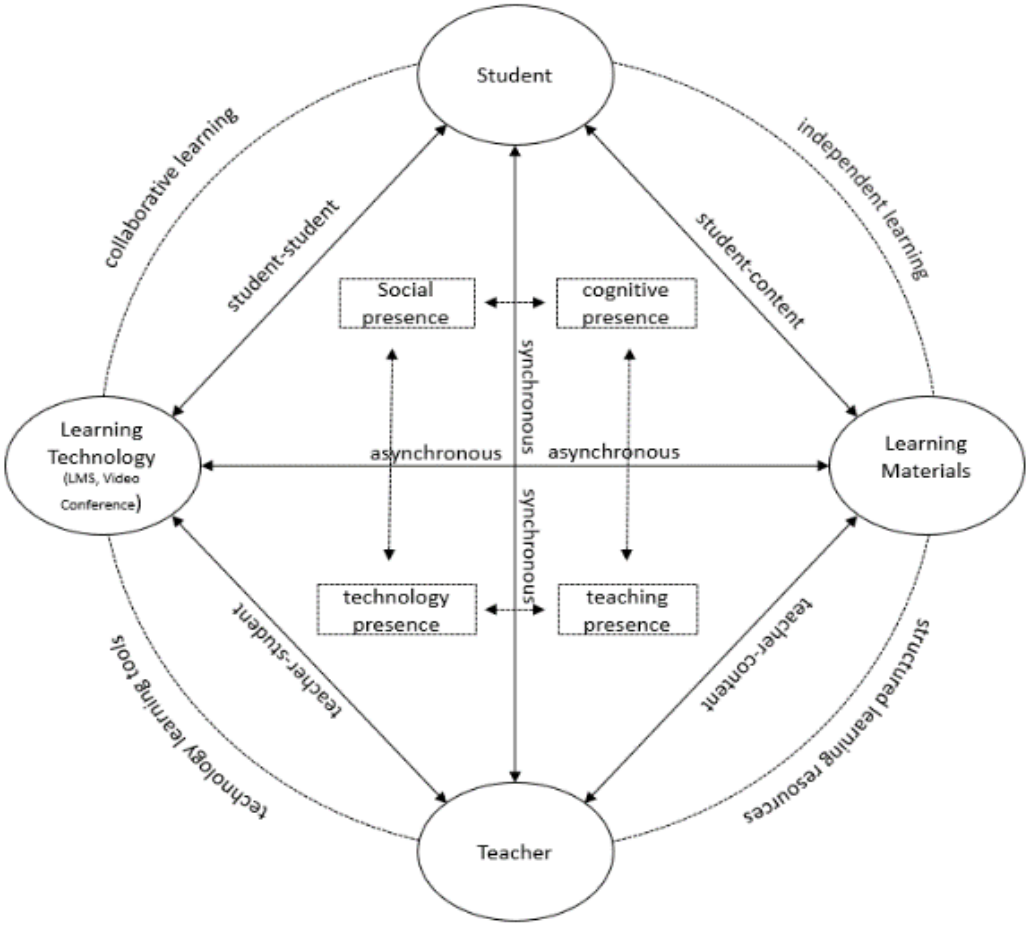

Figure 3. Revised Community of Inquiry (CoI) Framework in The BIL Model

The figure illustrates the critical interactions between students, teachers, teaching materials, and learning technologies so that they are intertwined in a learning environment that combines synchronous and asynchronous learning. Students are at the center of the learning process. They can interact collaboratively with other students through learning technologies such as LMS and video conferencing or independently with teaching materials to explore the material. Teachers play a role in guiding the learning process by using structured teaching materials, both synchronously and asynchronously, to ensure the achievement of learning objectives. The interaction between these elements is supported by four types of Presence: Social Presence, which enhances connections between students; Cognitive Presence, which facilitates deep understanding of the material; Teaching Presence, which demonstrates the teacher's role in organizing learning; and Technology Presence that serves as a link between all components, enriching the learning experience through digital tools. This study contributes to advancing blended learning practices by demonstrating the critical role of these four types of Presence in enhancing learning outcomes and by proposing the inclusion of Technology Presence into the Community of Inquiry (CoI) framework to address the demands of digital-era education.

LIMITATION

This study has limitations, especially the context being limited to a particular institution or student characteristics. The measurement tools used may not be fully comprehensive for social presence, cognitive presence, teaching presence, and technological presence, as well as the lack of consideration of external factors such as student motivation or socioeconomic conditions that may affect learning outcomes.

CONCLUSION

This research shows that technology presence has the most significant influence on the effectiveness of Blended Inquiry Learning, followed by teacher presence, cognitive presence, and social presence. Technology plays an essential role in enhancing student accessibility, interaction, and collaboration, while effective teaching supports student engagement and the development of critical thinking. Cognitive presence helps students engage in critical and reflective thinking processes. Social presence, while important for building connections and learning communities, has little impact on learning effectiveness. This study confirms that harmonious integration between the four elements is necessary to improve learning outcomes in Blended Inquiry Learning. It is recommended that future research involve a larger number of respondents with diverse backgrounds, including different levels of education, learning styles, and technology preferences, to improve the generalisability of the findings. Furthermore, more comprehensive measurement tools, such as high-validity questionnaires, in-depth interviews, and application-based data analysis, are recommended to facilitate a more in-depth exploration of both qualitative and quantitative aspects. Additionally, external variables, such as technology availability, learning environment, and support from educators or parents, should be considered to provide a more comprehensive picture of the effectiveness of blended inquiry learning in various contexts.

AUTHOR CONTRIBUTIONS

BR led the research design, implementation, data collection, statistical analysis, and initial drafting of the manuscript. MF played a significant role in the research design and interpretation of the data analysis. DY reviewed and revised the manuscript for intellectual depth and content. RF helped to draft the research instruments, data collection, and statistical analysis.

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