Asian Journal of Contemporary Education
ISSN(e): 2617-1252
DOI: 10.55493/5052.v9i1.5316
Vol. 9, No. 1, 55-69.

Direct antecedents of collaborative learning in open online flexible distance learning for higher education students

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Article History
Received: 23 January 2025
Revised: 28 February 2025
Accepted: 12 March 2025
Published: 24 March 2025

Keywords
Collaborative learning
Interaction with peers
Interaction with tutors
Learners' self-efficacy
Social media usage
Social presence.

ABSTRACT

This study explores the acceptance of collaborative learning among learners in online flexible distance learning environments. This study examines the direct effects of interaction with peers and tutors, social media usage, learners' self-efficacy, and social presence on collaborative learning. The study employed a survey-based data collection technique, distributing questionnaires and 388 were deemed suitable for the analysis. The data were analysed using structural equation modeling (SEM) with SmartPLS4 software to assess the relationships and test the hypotheses. Hypotheses testing revealed that while interaction with peers and social presence did not significantly influence collaborative learning, tutor interaction, learners' self-efficacy, and social media usage had significant positive effects on collaborative learning. These results suggest that future studies should investigate the underlying reasons for the non-significant impact of peer interaction and social presence, possibly by examining different technological tools or pedagogical approaches. The study's implications extend to educational policymakers and practitioners. It recommends targeted interventions to build student self-efficacy and integrate social media effectively within the learning process. Institutions can create more engaging and successful collaborative learning environments, ultimately fostering improved academic performance and student satisfaction in online flexible distance learning.

Contribution/ Originality: This study analyses the direct impact of interaction with tutors, learners' self-efficacy and social media use, as well as examining non-significant factors such as social presence and interaction with peers.

1. INTRODUCTION

Collaborative learning in open online flexible distance learning (OOFDL) higher education has gained prominence due to its potential to enhance student engagement and outcomes. This approach leverages diverse perspectives and encourages knowledge co-construction, leading to deeper understanding and retention of information (Kebah, Raju, & Osman, 2019). Using digital platforms and tools for collaborative learning allows students to engage actively, regardless of geographical boundaries, making education more accessible and inclusive (Saw & Mohamad, 2024). Current trends in collaborative learning emphasize the integration of social media and other digital tools (Kebah et al., 2019). Platforms like WhatsApp have facilitated real-time discussions and

collaborative knowledge creation in online distance learning programs (Belle, 2024). However, challenges such as ensuring equal participation and managing the technological divide can affect the effectiveness of these collaborative environments (Matee, Motlohi, & Nkiwane, 2023). Additionally, the need for developing transferable skills through online learning environments is recognised, yet implementing practical approaches remains challenging (Weng, Kassaw, Astatke, & Yang, 2024). Despite its advantages, research on collaborative learning in OOFDL highlights several gaps. One significant gap is the lack of comprehensive studies on the impact of collaborative learning on diverse student demographics and educational contexts (Salama & Hinton, 2023). Moreover, understanding the determining factors that influence successful collaborative learning through social networks remains underexplored (Boruzie, Kolog, Afful-Dazie, & Egala, 2024). Addressing these gaps is crucial for enhancing the effectiveness of collaborative strategies in OOFDL. From a research perspective, there is also a need to explore the role of constructivist learning approaches in fostering creative thinking skills, with online collaborative environments serving as mediators (Vijayakumar Bharathi & Pande, 2024). Additionally, the potential for collaborative online learning based on inter-university systems offers unexplored opportunities for enhancing educational partnerships and learning outcomes (Soetopo et al., 2023). The significance of studying collaborative learning in OOFDL for policymakers, educators, and students cannot be overstated. For policymakers, a deeper understanding can guide the development of frameworks that enhance access and equity in education. Institutions can leverage insights from research to design more effective collaborative learning environments that cater to diverse student needs (Aithal, Prabhu, & Aithal, 2024). Students benefit through improved engagement, knowledge retention, and skill development, equipping them for the demands of the modern workforce (Culduz, 2024). Consequently, addressing the challenges and research gaps in collaborative learning is essential for advancing education in a digital era. This study aims to evaluate the direct influence of interaction with peers, social presence, social media usage, and interaction with tutors on collaborative learning with learners' self-efficacy as a mediator among the students in open online flexible distance learning (OOFDL) in higher education institutions.

2. LITERATURE REVIEW

2.1. Underpinning Theory

Social Constructivism Theory, developed by Vygotsky (1978) emphasises the significance of social interaction and cultural context in developing cognitive functions. Vygotsky proposed that learners construct knowledge through interactions with others and that learning is inherently a social process rather than an isolated activity (Vygotsky, 1978). This theory is particularly relevant to the study of collaborative learning in open online flexible distance learning (OOFDL) as it accounts for the diverse interactions that constitute the learning environment. In the context of OOFDL, interaction with peers becomes a critical component of social constructivist learning. Peer interactions facilitate the exchange of ideas, promote understanding, and support co-construction of knowledge, which are foundational to collaborative learning (Palincsar, 1998). The social presence in online courses enhances student engagement and creates a sense of community, which is essential for effective collaboration and deeper learning (Garrison, 2007). The role of social media in collaborative learning further underscores the relevance of social Constructivism. Social media platforms provide dynamic spaces for learners to engage in discussions, share resources, and receive feedback, enabling the social interactions necessary for constructing knowledge (Selwyn, 2012). Social media facilitates real-time and continuous collaboration, reflecting Vygotsky's notion of learning as a socially mediated process. Learners' self-efficacy, or their belief in their ability to succeed, is also shaped by social interactions and feedback. Encouragement and constructive feedback from peers and tutors can boost self-efficacy, making learners more confident in engaging with collaborative tasks (Bandura, 1997). Tutor interaction provides guidance and scaffolding, helping learners reach higher levels of understanding, akin to Vygotsky's concept of the Zone of Proximal Development (ZPD), where learners can achieve more with guidance than independently.

2.2. Relationship between Interaction with Peers and Collaborative Learning

Interaction with peers is crucial in enhancing collaborative learning, particularly in online distance learning environments. Peer interaction facilitates the sharing of diverse perspectives and knowledge, encouraging students to engage in meaningful discourse and collaborative problem-solving (Chatterjee & Correia, 2020). In an online setting, these interactions often occur through discussion forums, group projects, and social media platforms, enabling learners to connect despite geographical barriers (Matee et al., 2023). The exchange of ideas among peers fosters a sense of community and belonging, which is essential for effective learning (Li, Rahman, Connie, & Osman, 2020). Such social interactions provide feedback and reflection opportunities, helping learners develop critical thinking skills and a deeper understanding of the subject (Haugland, Rosenberg, & Aasekjær, 2022). Students can pool their resources and expertise by working collaboratively, enhancing the learning experience beyond individual capabilities (Intaratat, Osman, Nguyen, Suhandoko, & Sultana, 2024). Moreover, peer interaction in online settings can increase motivation and engagement. Students working together towards a common goal are more likely to stay committed and invested in their learning activities (Qureshi, Khaskheli, Qureshi, Raza, & Yousufi, 2023). The mediator role of intra-group emotional support in peer interaction further enhances collaborative learning by creating a supportive environment (Lyu, Li, Wang, Xiao, & Zhu, 2024).

Therefore, the following hypothesis was proposed for this study:

H_1: There is a direct relationship between interaction with peers and collaborative learning among the students in open online flexible distance learning (OOFDL) in higher education institutions.

2.3. Relationship between Interaction with Tutors and Collaborative Learning

Interaction with tutors is crucial to collaborative learning in online distance learning environments. Tutors play multiple roles, including facilitating discussions, providing guidance, and offering feedback, which is essential for fostering effective collaboration among students (Wang & Liu, 2024). Their involvement helps bridge the gap between learners and the course material, ensuring all participants are engaged and clearly understand collaborative objectives (Osman, Mohamad, Mohamad, Mohamad, & Sulaiman, 2018). In online settings, tutors facilitate collaborative learning by designing activities requiring all group members' input. They encourage students to share their perspectives and build on each other's ideas (Tran, Weng, Tran-Nguyen, Astatke, & Tran, 2024). This guided interaction helps students develop a deeper understanding of the content and learn from diverse viewpoints. Tutors also provide timely feedback, helping students refine their thoughts and approaches, thereby enhancing the collaborative process (Xanthopoulou, Sahinidis, Solomou, & Lappa, 2024). Moreover, tutors help establish a supportive learning environment by maintaining an active presence and encouraging open communication. This presence increases students' confidence in contributing and engaging actively in collaborative tasks (Boruzie et al., 2024). Such involvement from tutors can significantly improve students' motivation and participation, ensuring that collaborative learning activities are productive and aligned with learning goals (Qureshi et al., 2023).

Thus, the following hypothesis was proposed for this study:

H_2: There is a direct relationship between interaction with tutors and collaborative learning among the students in open online flexible distance learning (OOFDL) in higher education institutions.

2.4. Relationship between Learners' Self-Efficacy and Collaborative Learning

Learners' self-efficacy, or belief in their capability to execute actions required to achieve specific performance goals, significantly influences collaborative learning in online distance learning environments. High self-efficacy enhances students' motivation and persistence, allowing them to engage in collaborative tasks proactively. This proactive engagement facilitates better communication, idea exchange, and critical thinking, all essential to effective collaborative learning (De Backer et al., 2022). Self-efficacy is crucial in online distance learning, where face-to-face

interaction is limited. Students with a strong sense of self-efficacy are more likely to take the initiative in group discussions, contribute valuable insights, and assist peers in overcoming learning challenges, thus enriching the collaborative experience for the entire group (Chen et al., 2024). Their confidence in their abilities encourages them to venture beyond their comfort zones and engage deeply with the material and their peers (Muslem, Bsharat, & Habibullah, 2024). Conversely, low self-efficacy can hinder participation as students may doubt their contribution's value or fear negative evaluation from peers (Mubarak & Selimin, 2024). Instructors can support the development of self-efficacy by providing constructive feedback, setting achievable goals, and creating a supportive online environment. This nurtures an atmosphere where students feel capable and valued, leading to more effective and meaningful collaborative learning experiences (Ghali & Amari, 2024). By fostering self-efficacy, educators can enhance the overall effectiveness and quality of collaborative learning in online settings.

Therefore, the following hypothesis was proposed for this study:

H_3: There is a direct relationship between learners' self-efficacy and collaborative learning among the students in open online flexible distance learning (OOFDL) in higher education institutions.

2.5. Relationship between Social Media Usage and Collaborative Learning

Social media usage enhances collaborative learning within online distance learning environments. The influence of social media usage showed that students engaging with social media are more inclined towards collaborative learning (Mohamad, Osman, & Nurhayati, 2024). Social media tools such as forums, groups, and chats enable real-time interaction and continuous engagement among learners, facilitating a collaborative learning atmosphere (Liu, Zaigham, Rashid, & Bilal, 2022). Through social media, students can quickly form study groups, participate in discussions, and collaboratively solve problems, creating a dynamic and interactive learning environment (Konstantopoulou, 2024). This interaction helps exchange ideas and build a sense of community and belonging among learners, which is crucial for motivation and sustained engagement (Qureshi et al., 2023). Additionally, the informal nature of social media communication can encourage more students to participate actively, as they may feel less intimidated compared to traditional classroom settings.

Furthermore, social media can serve as a platform for feedback and peer review, allowing students to give and receive constructive criticism, which is vital for personal and academic growth. By integrating social media into collaborative learning strategies, educators can leverage its potential to promote more interactive, inclusive, and student-centred learning experiences, ultimately enhancing the effectiveness and engagement of online distance education (Zhang et al., 2024).

Hence, the following hypothesis was proposed for this study:

H_4: There is a direct relationship between social media usage and collaborative learning among the students in open online flexible distance learning (OOFDL) in higher education institutions.

2.6. Relationship between Social Presence and Collaborative Learning

Social presence is critical in facilitating collaborative learning in online distance learning environments. It refers to the degree to which participants in online communication feel socially and emotionally connected (Alsayer & Lowenthal, 2024). A strong sense of social presence can significantly enhance students' learning experiences by fostering a sense of community and belonging, essential for effective collaboration (Guo, Long, & Amari, 2023). In online education, where face-to-face interaction is absent, establishing a social presence helps bridge the gap, making interactions feel more personal and engaging. Learners who perceive a high social presence are likelier to participate actively in discussions, share ideas openly, and collaborate effectively with peers (Bersamin, Ulla, Saripa, & Suebsom, 2024). This sense of connection encourages students to contribute meaningfully to group tasks and discussions, enriching the collaborative learning process. Additionally, social presence can reduce feelings of isolation and disconnection commonly associated with online learning, thereby increasing student satisfaction and

motivation (Aldosari, Alzahrani, & Alzahrani, 2022). The enhanced communication and interaction facilitated by a robust social presence can lead to greater engagement and a deeper understanding of the course material. Educators can promote social presence using interactive tools like video conferencing, discussion boards, and social media, allowing real-time feedback and personal interaction. By nurturing social presence, educators can create more supportive and dynamic online learning environments that foster effective collaborative learning (van der Stap, van den Berg, & Amari, 2024).

Thus, the following hypothesis was proposed for this study:

H_5: There is a direct relationship between social presence and collaborative learning among the students in open online flexible distance learning (OOFDL) in higher education institutions.

Based on the hypotheses, the research framework is shown in Figure 1 which interaction with peers, social presence, social media usage, learners' self-efficacy and interaction with tutors are the independent variables and collaborative learning is the dependent variable.

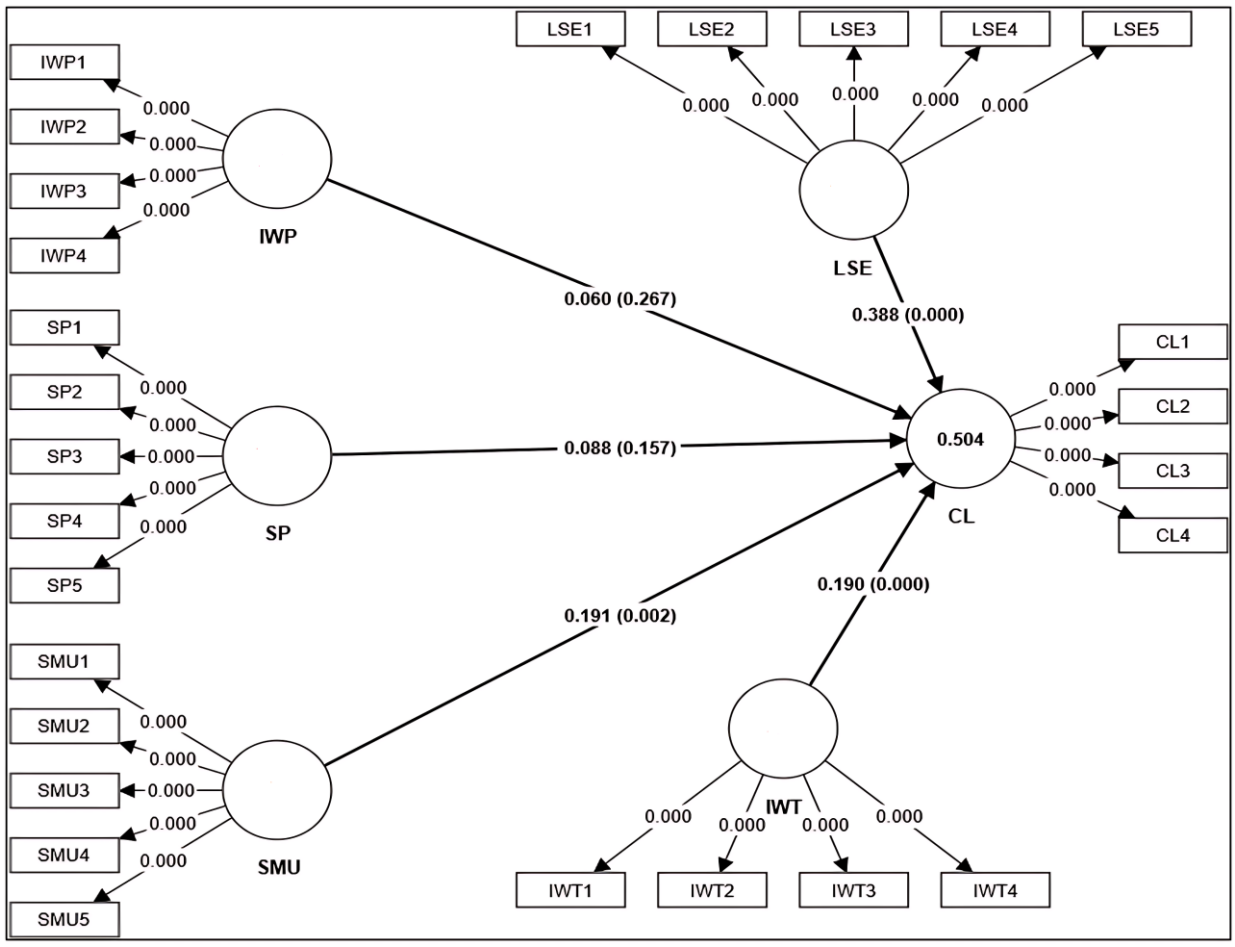

Figure 1. Research framework.

Note: IWP=Interaction with peers; SP=Social presence; SMU=Social media usage IWT=Interaction with tutors; LSE=Learners' self-efficacy; CL=Collaborative learning.

3. METHODOLOGY

This study examined the direct effects of peer interaction, interaction with tutors, social media use, social presence, and student self-efficacy on collaborative learning in flexible online distance learning at higher education institutions. Data collection used validated and reliable instruments, as identified through a comprehensive literature review. Due to the lack of a complete population list, a questionnaire was designed and distributed via email to respondents selected through purposive sampling. Respondents consisted of learners pursuing flexible distance learning at higher education institutions. This study assessed 27 variables, including independent variables

such as interaction with tutor (4 items) (Abrantes, Seabra, & Lages, 2007) interaction with peers (4 items) (Sarwar, Zulfiqar, Aziz, & Ejaz Chandia, 2019) social presence (5 items) (Molinillo-Jiménez, Aguilar-Illescas, Anaya-Sánchez, & Vallespín-Arán, 2018) social media use (5 items) (Sarwar et al., 2019) and student self-efficacy (5 items) (Kang, Chang, Kao, Chen, & Wu, 2019). The dependent variable for this study was collaborative learning (4 items) (Al-Rahmi & Othman, 2013). Respondents rated each variable using a five-point Likert scale, resulting in a comprehensive data set. Of the 507 questionnaires distributed, 412 were returned, with a response rate of 81.2%, sufficient for structural equation model (SEM) analysis. Finally, 388 responses were eligible for analysis. SmartPLS4 software was used because of its ability to handle SEM techniques effectively, as supported by Ringle, Wende, and Becker (2022). This software allows for thorough hypothesis testing and multivariate data analysis, providing an in-depth examination of measurement models and structural models.

4. DATA ANALYSIS

4.1. Respondents Profile

The respondents' profile provides a comprehensive demographic snapshot, illustrating a balanced gender distribution with a slight majority of females, comprising 51.3% (199 respondents), compared to 48.7% of males (189 respondents). The age distribution of the respondents highlights a dominant representation of those aged 31-40 years, accounting for 44.6% (173 respondents), followed closely by those under 30 years at 39.7% (154 respondents). The segment comprising 41-50-year-olds forms 12.4% (48 respondents), whereas the older age group of 51-60 years constitutes a smaller portion at 3.4% (13 respondents). When examining the year of study, the distribution indicates the highest representation from third-year students at 24.7% (96 respondents), followed by those in their second year at 20.9% (81 respondents), and first-year students at 18.6% (72 respondents). There was decreasing engagement in Year 4 at 16.2% (63 respondents), Year 5 at 11.6% (45 respondents), and Year 5 at 8.0% (31 respondents). Regarding academic programs, a substantial portion of the respondents are pursuing Diplomas, making up 65.7% (255 respondents), underscoring its popularity or availability as a practical qualification pathway. Certificates follow at 21.4% (83 respondents), indicating a considerable interest in shorter, potentially skill-focused educational pursuits. Bachelor's, Master's, and Doctorate programs are less represented, with 7.0% (27 respondents), 4.9% (19 respondents), and 1.0% (4 respondents), respectively. Finally, regarding the likelihood of recommending collaborative learning, an overwhelming 99.2% (385 respondents) expressed a positive inclination, suggesting widespread satisfaction or a positive perception of the collaborative learning aspect of their education. In comparison, only 0.8% (3 respondents) indicated otherwise.

4.2. Common Method Bias

The full multicollinearity test results shown in Table 1 were used to evaluate the potential for standard method bias, following the guidelines by Kock and Lynn (2012) and Kock (2015). Identifying standard method bias involves assessing collinearity among latent variables, with a variance inflation factor (VIF) over 3.3 indicating problematic collinearity and potential standard method bias. In the current study, all VIF values fall below the 3.3 threshold, ranging from 1.237 to 1.951. The highest VIF observed is 1.951 for the relationship between Social Media Usage and Social Presence, which remains comfortably within acceptable standards. These findings suggest the absence of significant standard method bias in the model, highlighting the robustness of the collected data. This ensures that the evaluated relationships among collaborative learning, interactions, social media usage, social presence, and learners' self-efficacy are not notably influenced by such bias, affirming the validity of the study's results and conclusions.

Table 1. Full collinearity test.

Constructs	CL	IWP	IWT	SMU	SP	LSE
CL		1.837	1.721	1.638	1.889	1.443
IWP	1.332		1.312	1.792	1.769	1.314
IWT	1.237	1.302		1.883	1.884	1.360
SMU	1.935	1.499	1.762		1.794	1.492
SP	1.754	1.437	1.825	1.951		1.789
LSE	1.290	1.621	1.692	1.731	1.812	

4.3. Measurement Model

This study employed the measurement evaluation technique outlined by Hair, Hult, Ringle, and Sarstedt (2017) by conducting first and second-stage assessments to identify items with loading values below 0.7. Reliability and construct validity evaluation showed that all constructs exceeded the Average Variance Extracted (AVE) 0.5 benchmark, with values ranging from 0.544 to 0.702, confirming convergent validity (Hair et al., 2017). The composite reliability of all constructs exceeded 0.7, with a range from 0.771 to 0.868, while Cronbach's alpha values were also above 0.7, ranging from 0.758 to 0.858, as detailed in Table 2. Initial cross-loading assessments were conducted to confirm discriminant validity and ensure that each construct reflected the correct dimensions (refer to Table 2). Next, Heterotrait-Monotrait (HTMT) ratios were used based on the Henseler, Ringle, and Sarstedt (2015) method to assess discriminant validity in the context of Variance-Based Structural Equation Modeling (VB-SEM). All HTMT ratios for the constructs were below the threshold of 0.85, as reported in Table 3, confirming adequate discriminant validity.

Table 2. Construct reliability and validity & items loadings.

Constructs	Items	Loadings	CA	CR	AVE
Collaborative learning	CL1	0.814	0.823	0.827	0.652
	CL2	0.814			
	CL3	0.828			
	CL4	0.772			
Interaction with peers	IWP1	0.797	0.758	0.771	0.584
	IWP2	0.813			
	IWP3	0.625			
	IWP4	0.806			
Interaction with tutors	IWT1	0.877	0.858	0.866	0.702
	IWT2	0.860			
	IWT3	0.853			
	IWT4	0.756			
Learners' self-efficacy	LSE1	0.803	0.852	0.854	0.628
	LSE2	0.823			
	LSE3	0.808			
	LSE4	0.746			
	LSE5	0.779			
Social media usage	SMU1	0.800	0.794	0.795	0.548
	SMU2	0.728			
	SMU3	0.751			
	SMU4	0.711			
	SMU5	0.709			
Social presence	SP1	0.762	0.846	0.868	0.619
	SP2	0.789			
	SP3	0.843			
	SP4	0.847			
	SP5	0.681			

Note: CA=Cronbach alpha CR=Composite reliability AVE=Average variance extracted.

Table 3. Hetrotrait-Monotrait (HTMT) ratios.

Constructs	CL	IWP	IWT	LSE	SMU
IWP	0.560				
IWT	0.552	0.492			
LSE	0.729	0.531	0.415		
SMU	0.659	0.645	0.504	0.574	
SP	0.604	0.765	0.474	0.564	0.808

4.4. Structural Model

In this study, the structural model was evaluated following the guidelines of Hair et al. (2017) emphasising a detailed analysis of path coefficients (β) and coefficients of determination (R^2). The Partial Least Squares (PLS) method was employed, with 5,000 sub-samples used to determine the significance of the path coefficients. Table 4 provides a comprehensive overview of the hypothesis testing results, including confidence intervals for the path coefficients (beta), t-statistics, and p-values. This detailed approach offers insights into the structural model's strength and the significance of relationships between variables. Table 4 reveals whether each hypothesis is supported by examining beta coefficients, T-statistics, and P-values. This rigorous methodology enhances the study's conclusions, providing a detailed understanding of the interactions among the variables analysed (Hair et al., 2017).

Analysing the hypotheses and testing results for the study provides insights into the relationships between different factors and collaborative learning. Hypothesis 1 *(H1)* posits that interaction with peers influences collaborative learning. The beta value is 0.060, with a t-statistic of 1.111 and a p-value of 0.267. These statistics do not support the hypothesis, as the p-value exceeds the conventional threshold of 0.05, leading to the rejection of H1. This suggests that peer interaction, in this context, does not significantly impact collaborative learning outcomes. Hypothesis 2 *(H2)* examines the effect of interaction with tutors on collaborative learning. The results show a significant beta value of 0.190, coupled with a t-statistic of 3.836 and a p-value of 0.000. The significance of these statistics supports the hypothesis, indicating that tutor interaction plays a crucial role in fostering collaborative learning; thus, H2 is accepted.

For Hypothesis 3 *(H3)*, regarding learners' self-efficacy, the beta coefficient is the highest among the tested hypotheses at 0.388, with a t-statistic of 7.723 and a p-value of 0.000. These strong statistical indicators provide compelling evidence to accept H3, highlighting the profound influence of self-efficacy on collaborative learning. Hypothesis 4 *(H4)*, which addresses the impact of social media usage on collaborative learning, has a beta value of 0.191, supported by a t-statistic of 3.114 and a p-value of 0.002. These results are statistically significant, leading to the acceptance of H4, which suggests that social media usage positively and significantly contributes to collaborative learning.

Lastly, Hypothesis 5 *(H5)* proposes that social presence affects collaborative learning, but the beta value is 0.088, with a t-statistic of 1.417 and a p-value of 0.157. Given that the p-value is above 0.05, H5 is rejected, indicating that, within the scope of this study, social presence is not a significant predictor of collaborative learning.

Table 4. Hypotheses testing results.

Hypotheses	Beta	T statistics	P values	2.50%	97.50%	Decision
H1: IWP -> CL	0.060	1.111	0.267	-0.047	0.164	Rejected
H2: IWT -> CL	0.190	3.836	0.000	0.093	0.285	Accepted
H3: LSE -> CL	0.388	7.723	0.000	0.288	0.485	Accepted
H4: SMU -> CL	0.191	3.114	0.002	0.067	0.304	Accepted
H5: SP -> CL	0.088	1.417	0.157	-0.037	0.203	Rejected

Note: Significant at $p<0.05$.

4.5. Effect Sizes (f^2) and Variance Inflation Factor (VIF)

Table 5 presents a comprehensive analysis of effect sizes (f^2) according to Cohen (1992) criteria, which classify effect sizes as small (0.020 to 0.150), medium (0.150 to 0.350), or large (above 0.350). The study's effect sizes range from small (0.004) to medium (0.210), indicating different levels of influence among the variables examined. Furthermore, the Variance Inflation Factor (VIF) values, documented in Table 5, remain well below the conservative threshold of 5, with the maximum value observed as 2.354. This indicates negligible collinearity issues, supporting the reliability of the structural model's interpretation regarding effect sizes and coefficients. The endogenous construct demonstrates a significant explained variance with an R^2 value of 0.504, as depicted in Figure 1.

Table 5. Effect sizes (f^2) & variance inflation factor.

Constructs	f^2	VIF
IWP	0.004	1.716
IWT	0.055	1.326
LSE	0.210	1.445
SMU	0.036	2.013
SP	0.007	2.354

4.6. PLSpredicts and Cross-Validated Predictive Ability Test (CVPAT)

Model conclusions and managerial implications were rigorously assessed using the PLSpredict methodology for out-of-sample predictive analysis, as recommended by Shmueli, Ray, Estrada, and Chatla (2016) and Shmueli et al. (2019). Table 6 illustrates that the application of PLS-SEM yielded noticeably higher Q^2 predictions (>0) when compared to naive mean predictions and consistently resulted in lower Root Mean Square Error (RMSE) values than those produced by linear model (LM) benchmarks. This underscores the model's predictive solid capabilities. Notably, PLS-SEM predictions surpassed all those from the LM prediction benchmark in four cases, as shown in Table 6, underscoring the model's substantial predictive accuracy. The introduction of the Cross-Validated Predictive Ability Test (CVPAT) by Hair, Hult, Ringle, and Sarstedt (2022) alongside its utilization in PLSpredict analysis by Liengaard et al. (2021) has significantly enhanced predictive modelling practices. As presented in Table 7, the PLS-SEM approach exhibits superior predictive performance, demonstrated by lower average loss values compared to indicator averages and LM benchmarks, providing compelling evidence of its enhanced predictive strength.

Table 6. PLS predicts.

Items	Q^2predict	PLS-RMSE	LM-RMSE	PLS-LM
CL1	0.396	0.588	0.604	-0.016
CL2	0.281	0.600	0.614	-0.014
CL3	0.310	0.647	0.673	-0.026
CL4	0.255	0.681	0.692	-0.011

Table 7. Cross-validated predictive ability test (CVPAT).

Constructs	Average loss difference	t-value	p-value
CL	-0.179	7.928	0.000
Overall	-0.179	7.928	0.000

4.7. Importance-Performance Map Analysis (IPMA)

Table 8 shows the significance-performance analysis of the five main constructs in collaborative learning in OOFDL. The Importance-Performance Map Analysis (IPMA), as recommended by Ringle and Sarstedt (2016) and Hair, Sarstedt, Ringle, and Gudergan (2018) offers a dual perspective by evaluating both the importance and

performance of constructs about collaborative learning. This analysis highlights "Learners' Self-Efficacy" as having the highest importance (0.388) but lower performance (60.753) compared to other constructs. Conversely, "Interaction with Peers" exhibits the lowest importance (0.060), and "Learners' Self-Efficacy" shows the lowest performance. To improve the impact of "Learners' Self-Efficacy" on collaborative learning, strategies should focus on enhancing students' confidence and belief in their abilities through personalised feedback, targeted skill-building activities, and peer mentoring programs. By increasing the performance of self-efficacy, institutions can foster a more effective and engaging collaborative learning environment. Additionally, workshops and training can be implemented to boost self-efficacy, aligning the importance and performance more closely to influence collaborative learning outcomes positively.

Table 8. Importance-performance map analysis (IPMA).

Constructs	Importance	Performance
IWP	0.060	66.742
IWT	0.190	67.017
LSE	0.388	60.753
SMU	0.191	67.306
SP	0.088	66.596

5. DISCUSSION AND CONCLUSION

To enhance interaction with peers, social presence, social media usage, and interaction with tutors in open online flexible distance learning (OOFDL) higher education, institutions can implement several practical strategies that harness learners' self-efficacy as a mediator to improve collaborative learning. The hypothesis testing results demonstrate that learners' self-efficacy has the highest beta (0.388), signifying its crucial role in facilitating collaborative learning when compared to other constructs such as interaction with tutors (0.190) and social media usage (0.191), both of which were significant predictors. Institutions should focus on strategies that bolster students' self-efficacy, as this enhancement amplifies the effects of collaborative learning components (Chen et al., 2024; De Backer et al., 2022). Enhancing peer interaction could involve creating structured virtual spaces that encourage collaboration, such as online forums and discussion groups designed explicitly for peer learning activities (Matee et al., 2023). These platforms can increase interaction and exchange of ideas, helping to foster a community of learning, despite the beta of interaction with peers (0.060) being non-significant. This might be due to insufficiently structured initiatives to support meaningful peer engagement in a virtual environment. Promoting social presence can be achieved by integrating video conferencing tools and real-time communication platforms to mimic face-to-face interactions, reducing the isolation often felt in online settings. These tools enhance communication and allow for spontaneous interaction, essential in building social presence (Guo et al., 2023). To leverage social media usage effectively in collaborative learning, institutions can integrate social media platforms into their learning management systems to facilitate informal learning and resource sharing. Integrating social media is essential for increasing students' confidence in their capacity to learn, which enhances their collaborative learning experiences (Mohamad et al., 2024).

Regarding tutor interaction, training tutors to be more actively present and engaged can have a profound impact. Tutors who provide timely feedback and create interactive sessions can boost student motivation and self-efficacy, leading to improved collaborative learning outcomes. The non-significant support for the effect of social presence (beta = 0.088) suggests the need for innovations in how presence is integrated into the online learning experience, indicating a possible gap in technology that fully captures the essence of in-person interaction (Aldosari et al., 2022). Therefore, strategic investments in robust communication technologies and training programs are essential for fostering a learning environment conducive to collaborative learning through enhanced self-efficacy.

5.1. Theoretical Implications

The theoretical implications of the study underscore the relevance and applicability of Social Constructivism as an underpinning theory, particularly in understanding the dynamics of collaborative learning within open online flexible distance learning (OOFDL) environments. This study highlights how key constructs, namely interaction with peers, social presence, social media usage, learners' self-efficacy, and interaction with tutors, are intricately supporting a comprehensive research model. Social Constructivism posits that knowledge is constructed through social interactions, aligning well with the finding that learners' self-efficacy significantly influences collaborative learning, reinforcing the importance of socially mediating constructs (Vygotsky, 1978). The significance of tutor interaction aligns with the necessity for guided learning and scaffolding, as posited by Vygotsky's Zone of Proximal Development, emphasising how instructor presence can enhance learner engagement and efficacy (Wang & Liu, 2024). Social media facilitates dynamic knowledge exchange, resonating with constructivist principles prioritising collaborative learning environments (Belle, 2024). Despite the non-significant effect of peer interaction and social presence, their potential lies in structured support systems and enhanced communication technologies that can better simulate in-person experiences, suggesting a refinement in how Social Constructivism is applied in digital contexts (Guo et al., 2023; Matee et al., 2023). Overall, the study contributes theoretically by affirming the substantial mediating role of self-efficacy in linking social constructivist elements with collaborative learning outcomes, suggesting avenues for future research to explore optimised interaction frameworks and integrating emerging educational technologies (Chen et al., 2024).

5.2. Practical Implications

The study's practical implications highlight several actionable strategies for enhancing collaborative learning in open online flexible distance learning (OOFDL) environments. By emphasising the significant role of learners' self-efficacy in mediating collaborative interactions, educational institutions can focus on developing programs that boost students' confidence and self-belief. This can be achieved through personalised feedback systems, mentorship programs, and courses designed to enhance self-efficacy, ultimately leading to improved collaborative engagement. Furthermore, the study underscores the importance of effective tutor interaction. Institutions should invest in tutor training programs that emphasise active engagement and the use of technology to facilitate real-time interaction with students. By doing so, tutors can provide timely guidance and foster a supportive virtual learning environment, which is crucial for student success. Integrating social media tools into the learning management system can also enhance connectivity and resource sharing among students, as indicated by the significant impact of social media usage. This integration can catalyse knowledge exchange and peer learning, fostering a more collaborative academic environment. The study suggests that educational institutions should adopt a comprehensive approach incorporating technological, pedagogical, and social strategies to improve collaborative learning outcomes and leverage learners' self-efficacy as a critical driver of success in OOFDL settings.

5.3. Suggestions for Future Study

Future studies could explore the nuanced roles of peer interaction and social presence, which showed non-significant effects in this study, to understand better the conditions and contexts under which these variables enhance collaborative learning. Investigating different technological tools and pedagogical approaches that simulate face-to-face interactions could provide deeper insights into maximising these elements. Additionally, examining the differential impact of these constructs across diverse demographic groups or varying academic disciplines could offer more tailored strategies for enhancing collaborative learning in OOFDL settings. Longitudinal studies may also provide valuable data on how learners' self-efficacy and collaborative learning evolve, offering insights into the sustained impact of educational interventions. Lastly, incorporating emerging technologies like virtual reality or AI-driven platforms could be explored to understand further their potential to support collaborative learning

frameworks. These directions would help refine and expand the theoretical and practical applications of the existing research model.

6. CONCLUSION

This study significantly advances our understanding of the factors influencing collaborative learning within open online flexible distance learning (OOFDL) environments. The research underscores the critical role of fostering student confidence to enhance collaborative experiences by identifying learners' self-efficacy as a pivotal mediator. The findings also highlight the importance of interaction with tutors and the effective integration of social media as critical contributors to successful collaborative learning. While peer interaction and social presence did not show significant effects, the study suggests opportunities for future exploration to harness their potential fully. Practically, the research offers actionable strategies for educational institutions to optimise their digital learning ecosystems through targeted interventions and technological enhancements. This study provides a comprehensive framework for leveraging key constructs to bolster collaborative learning in OOFDL settings, paving the way for more effective and engaging online education.

Funding: This research is supported by Open University Malaysia (Grant number: OUM-IRF-2024-031).
Institutional Review Board Statement: The Ethical Committee of the Open University Malaysia, Malaysia has granted approval for this study on 1 October 2024.
Transparency: The authors declare that the manuscript is honest, truthful and transparent, that no important aspects of the study have been omitted and that all deviations from the planned study have been made clear. This study followed all rules of writing ethics.
Data Availability Statement: The corresponding author can provide the supporting data of this study upon a reasonable request.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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