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Integrating virtual exchanges into ICAP learning designs: A bisymmetric analysis of online engagement and essay writing skills

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ABSTRACT

The purpose of this study was to investigate the impact of integrating virtual exchanges in ICAP (Interactive, Constructive, Active, and Passive) learning designs on online engagement, their role in shaping learning approaches, and their impact on essay writing skills. This study involved 250 students from the Indonesian language education study program at a university in Indonesia. It used a factorial analysis design to examine the correlation between components. Additionally, a quasi-experimental method was employed to assess the intervention's effect on essay writing skills. The instruments used included an online engagement questionnaire (covering cognitive, behavioral, and emotional aspects) and an essay writing skill assessment. Data analysis involved bisymmetric analysis integrating Necessary Conditional Analysis (NC), partial least squares modeling (PLS-SEM), and ANCOVA. The integration of virtual exchanges in active, interactive, constructive, and passive learning designs significantly impacted online engagement during the writing learning process. Through this online engagement, students could construct new knowledge both individually and collaboratively. Among the components of online engagement cognitive, behavioral, and emotional cognitive engagement in learning design had the most significant impact on students' in-depth approach. Furthermore, the intervention was more effective than conventional writing instruction in improving essay writing skills, particularly in aspects such as cohesion, coherence, grammatical range and accuracy, and vocabulary. This research emphasizes the importance for instructors to focus not only on individual cognitive abilities but also on collaboration and online engagement within the context of virtual exchanges.

Contribution/Originality: The main contribution and originality of this paper is the integration of virtual exchanges into an ICAP (Interactive, Constructive, Active, and Passive) design. Furthermore, this study investigates the impact of this instructional design on essay writing skills and online engagement.

1. INTRODUCTION

As the use of educational technology in language learning continues to grow, the use of virtual media has become increasingly attractive in computer-assisted language learning and is a key component of intercultural communication (Singh, Murthy, Kumar, & Raval, 2024; Yakobi & Yakobi, 2025). Virtual exchange is an online communication tool that facilitates students' participation in the language learning process anywhere and simultaneously provides opportunities for students to enhance intercultural competence through collaborative assignments (Kiziltaş & Kultas, 2025; Vallarino, Cersosimo, Torre, & Vercelli, 2025). Several previous studies have revealed that the use of virtual exchange media can develop language skills, intercultural communication competencies, and higher-order thinking

skills (Crook et al., 2025; Khuder & Negretti, 2026). In a recent study, several strategies were integrated into this virtual exchange technology to explore its role in language learning, optimize the role of teachers, and enhance intercultural communication competencies (Li & Hebert, 2024; Zhang & Zhang, 2025). However, the analysis also found inconsistencies between language learning plans and their implementation. Furthermore, previous studies have not been able to investigate teachers' virtual exchange procedures from a language learning perspective. Other studies have revealed that frequent use of virtual exchange can improve language learners' language skills and intercultural communication competencies (Holdinga, van Drie, & Rijlaarsdam, 2026; Ng & Graham, 2026). However, previous studies have not revealed information on teachers' procedures for integrating and using virtual exchange tasks to promote intercultural communication competencies. The study also analyzed teachers' cultural awareness and proficiency, such as their knowledge of pedagogical content and TPACK (Teacher Pedagogical Content Knowledge) when using virtual exchanges (Paulsen & Davidsen, 2025; Ten Peze, Janssen, Rijlaarsdam, & van Weijen, 2024). However, previous studies have focused solely on teachers' cultural and technological awareness, pedagogical literacy to enhance intercultural communication competency, and language use as final competencies (Bonnamy, Bugeja, Morphet, Russo, & Brand, 2024; Wang, Dede, Grotzer, & Chen, 2025).

Previous studies have not addressed students' cognitive, emotional, and behavioral activity aspects. To address this research gap, the current study focuses on the integration of virtual exchanges based on a taxonomy of interactive, constructive, active, and passive learning designs, and considers students' perspectives. This learning environment creates uncertainty in several aspects, such as the presentation of assignments and materials. Motivation, involvement, and self-control are psychological characteristics that are essential for success when utilizing virtual media (Brydon, Waitz-Kudla, Gomez, López, & Witte, 2025; Peungcharoenkun & Waluyo, 2023). Through these aspects, students are able to overcome the difficulties and complexities of online learning and contribute to improved academic performance. Students must be able to develop cognitive, affective, and behavioral aspects to succeed in participating in the online learning process. The complex dynamic systems of motivation, self-regulation, involvement, and emotional factors in language acquisition have not received much attention in research on the process of virtual exchange (Mogesse, Degefu, & Degaga, 2025; Subandowo, 2024). This online learning process through virtual exchange remains under-researched, even though this scaffolding is quite successful from a psycholinguistic perspective. In this study, researchers aimed to examine not only the quality of virtual exchange integration but also the effects of this integration on students' online participation and their methods of engaging with virtual exchange learning. Based on this explanation, this study formulated several questions, including.

a) How does the factorial framework of validity and reliability apply to constructive, active, and passive learning models in CAL and students' strategies for virtual exchange?
b) How do interventions affect students' online engagement levels in virtual exchanges?
c) How does the intervention impact essay writing skills?

2. LITERATURE REVIEW

2.1. Interactive, Constructive, Active, and Passive Learning Activity Framework

Most teachers fall into the category of using ICT in language learning with moderate or high frequency. Furthermore, they feel comfortable using it and are satisfied with its use. In actuality, though, there is not enough data to support the efficacy of ICT use in language learning (Lee & Chae, 2025; Wang & Wang, 2025). The frequency of technology use does not provide information on the pedagogical basis for technology integration. This hinders exploration of the long-term implications of technology use in teaching and learning. This gap is addressed by the interactive, constructive, active, and passive learning framework, which examines learning activities by considering cognitive participation in the learning process (Algouzi & Hazaea, 2023; Lin & Yu, 2025). The benefits of using technology in the classroom will be greatest when its use aligns with the learning objectives of the teaching and learning procedures. This pertains to the use of virtual exchange technologies in language instruction as well.

Consequently, the implementation of virtual exchange in language education necessitates a thorough analysis of the educational principles that support its application (Jin, 2025; Liu, Xin, & Chen, 2025).

This problem in virtual exchange research has not been addressed in a number of earlier studies. This study examines the degree of online student engagement in language learning activities using this interactive, constructive, active, and passive learning framework. This study provides in-depth insight into the quality of the integration of virtual media use in learning. Based on the consideration of the research context of language learning through virtual exchange, the concepts of interactive, constructive, active, and passive learning used are: interactive is a virtual learning activity that encourages interaction and collaboration between students to build knowledge based on previous knowledge and new information (Mekheimer, 2025; Reginald, 2023). Constructive is an individual activity in virtual learning that provides students with the opportunity to acquire knowledge and build correlations between that knowledge, such as designing concept maps, conducting comparative analyses of concepts, and solving problems (Singh et al., 2024; Yakobi & Yakobi, 2025). This process is expected to enable the passing of the presented material. Active learning is an activity that provides students with the opportunity to utilize their knowledge in the learning process through virtual exchange. Passive learning is the activity of the teacher in presenting material content through virtual media, with students playing only a receptive role (Terkaj, Urgo, Kovács, Tóth, & Mondellini, 2024; Vallarino et al., 2025).

2.2. Online Student Engagement and Virtual Exchange Approach in Language Learning

Currently, student engagement in online learning has become a vital aspect of academic development and achievement, along with the growing use of technology in the learning process. Students who actively participate in the learning process are said to be engaged or participating. Several concepts exist regarding the definition of engagement, including a) involvement in conditional contexts such as classroom learning activities and social welfare promotion; b) modal contexts encompassing short-term and long-term engagement (Crook et al., 2025; Khuder & Negretti, 2026).

Analysis of the literature reveals three dimensions of student engagement relevant to language learning: behavioral engagement, cognitive engagement, and emotional engagement (Ng & Graham, 2026; Zhang & Zhang, 2025). Behavioral engagement refers to student involvement in learning activities such as paying attention, asking questions, expressing opinions, and exchanging information, resulting in initiative. Cognitive engagement is a student's cognitive effort to develop the skills and knowledge necessary to solve complex problems in language learning. Emotional engagement is a student's affective response to the ongoing and past language learning process (Ten Peze et al., 2024; Wang et al., 2025).

Language learning involves information processing on two levels: deep processing and surface processing. From this idea, educational methods are developed. Experts characterize the surface approach as a learning method focused on memorization and reproduction of content to fulfill educational tasks (Bonnamy et al., 2024; Malpique, Valcan, Pino-Pasternak, & Ledger, 2025). This method is seen as ineffective in assisting students to identify the connections between concepts and ideas.

Additionally, the deep approach is a method of learning that aims to comprehend educational content by employing critical thinking abilities and meaningful learning to improve students' personal insights (Ebrahimi & Ebadi, 2024; Taufiqulloh, Nindya, Sulistyawati, & Sumekto, 2025). Previous studies have validated students' methods in online language learning environments (Shulgina, Costley, Shcheglova, Zhang, & Sedova, 2024). The analysis of earlier research defines the deep approach as a way to enhance critical thinking abilities via virtual exchanges, which are closely linked to students' engagement in interaction and information sharing (Tao, Cukurova, & Song, 2025; Usher, Roll, Fuhrman, & Amir, 2025). This differs from the surface approach, which reduces significant interactions and online classroom activities, leading to limited use of virtual media.

3. METHODOLOGY

3.1. Design and Participants

This study employed a factorial analysis design to examine the correlation between components of virtual exchange integration, including interactive, constructive, and active learning designs, and student online engagement. Additionally, a quasi-experimental approach was used to assess the contribution of virtual exchange integration within these learning designs interactive, constructive, active, and passive to student online engagement and writing skills. The research involved 250 students enrolled in the Indonesian language study program at Suryakancana University in Indonesia, spanning from the third to seventh semester. Participants were divided into two groups: the experimental group received a computer-assisted virtual exchange integration intervention within the specified learning designs, while the control group received conventional in-class instruction. The age range of participants was 20 to 22 years, with 60% female and 40% male. Participation was voluntary, with all participants signing a consent form after being informed about the study. The data collected was used solely for research purposes and maintained anonymously. A detailed overview of participant demographics is provided in Table 1.

Table 1. Demographic information of research participants.

Variables	Description	N	%
Gender	Male	125	50%
	Female	125	50%
	Years		
Age	19–22	200	80%
	23–25	45	18%
	> 25	5	2%
	Years		
Online language learning experience	4–5	46	49.5%
	> 6	43	44.2%

3.2. Research Instruments

This study used a rubric to assess students' online engagement during the virtual exchange process and an instrument to evaluate essay writing skills. These two tools were employed to investigate the impact of integrating virtual exchanges into an interactive, constructive, and active learning design on students' online engagement and writing skills.

3.2.1. Online Engagement

Online engagement was assessed using a scale of student activeness or participation during virtual exchanges adapted from Chan (2008). This scale encompasses students' self-development efforts through active engagement during the online learning process. The assessment scale consists of 20 items with a 0-5 point scale, designed to evaluate students' attitudes and values during online engagement. The activeness assessment was adjusted to align with the attitudes and values developed in the Indonesian curriculum. Online engagement was evaluated based on several criteria, namely, level of activeness, rationality, appreciation, and optimism. Students who scored high on this online engagement demonstrated not only active participation in the learning process but also exhibited attitudes capable of absorbing many values from the course during the intervention and maintaining a positive attitude toward the instructor. This instrument was empirically tested on 50 students to determine its validity and reliability. The researcher applied Pearson's product-moment correlation analysis to assess validity and used the split-half method to evaluate reliability. This method involves direct evaluation of the linear correlation between questions. The analysis revealed an average Pearson correlation coefficient of 0.87 across all questions.

3.2.2. Essay Writing Assignment

Writing skills were evaluated through essay writing assignments 1 and 2 for both groups. Both assignments were in essay format and assessed using the CEFR writing descriptors. The evaluation was conducted across four aspects: task achievement (decomposition of main points, presence of an overview, factual data, and word count meeting criteria), cohesion and coherence (organization of ideas, paragraph format, and conjunctions), lexicon (use of terminology, collocations, and sentence structure), and grammatical range and accuracy (use of grammar, punctuation, and errors). Each aspect of the assessment was scored from 1 to 9 points. For task achievement, a score of 9 indicates that the assignment was met by presenting a claim, expanding it with various ideas, and supporting it with data. For cohesion and coherence, a score of 9 indicates the correct and effective use of cohesive devices and structures. For lexical aspects, a score of 9 indicates the appropriate use of vocabulary and idioms. The final score was obtained from the sum of both writing assignments, with scores ranging from 1 to 9 in increments of 0.5. The validity of this instrument was tested using empirical testing on the same group of participants to measure construct validity. The test results showed reliability that met the criteria, with a Cronbach's alpha value of 0.92. Based on this value, this instrument was suitable for use in research. All instruments were used in the pre-test and post-test phases.

3.3. Procedure

In the pretest phase, students' essay writing skills were assessed to ensure that all students' writing abilities were equal. The intervention was conducted over one semester, with three asynchronous virtual exchanges. Furthermore, the intervention was supplemented with asynchronous virtual sessions through various media such as WhatsApp, Google Classroom, and Moodle. The primary virtual media used for the intervention were Zoom and a virtual reality platform. In the initial phase, students were given the opportunity to introduce themselves and ask questions about writing to loosen up the learning atmosphere. The essay topics were technology, social issues, and the environment. In this phase, the instructor provided essay writing materials, including text organizational structure and writing techniques, on a spatial VR platform through immersive synchronous online meetings (constructive learning). Students acted as receptive individuals, understanding the material (passive) before entering the exploration phase. In the exploration phase, students were divided into groups, and each group was given the opportunity to engage in discussions in their respective virtual media rooms to explore their chosen topic.

During this exploration phase, students were given the opportunity to seek additional references from books, the internet, and other media to supplement their essay writing (active and constructive learning). In the evaluation phase, students were instructed to write essays. At this stage, students in their groups could collaborate and exchange ideas, providing feedback and suggestions on each other's essays through virtual exchanges (interactive learning). In each learning cycle, students were asked to write essays to be shared with their group members for peer feedback (constructive and interactive learning). Essays that had received peer feedback were uploaded to Moodle. The writing learning process at each phase, using various media, required students to write scripts to prepare them for digital stories. Videos, voiceovers, and Indonesian subtitles were used to develop the writing process (active and constructive learning). Students were requested to give comments on these digital stories (interactive learning) once they were exported in a manner that worked with Google Classroom.

3.4. Data Analysis

This research utilized a bisymmetric framework in technology-aided language learning. Data analysis integrated Necessary Conditional Analysis (NCA) and partial least squares modeling (PLS-SEM) to explore the intervention process and the effects of intervention outcomes on writing skills. Symmetric analysis employed partial least squares modeling (PLS-SEM), specifically least squares analysis and principal component analysis, to create a systematic and organized conceptual model. This analysis employs additive sufficiency reasoning by examining contributing factors and forecasting results. Additionally, to examine the effect of the intervention on essay writing abilities, ANCOVA

data analysis along with descriptive statistics were employed. This data analysis aimed to examine the distinctions between the two experimental and control groups. Furthermore, PLS-SEM can forecast direct, indirect, and serial relationships among variables and aligns with the stimulus-response model presented in this research. The combination of the two quantitative methods, PLS-SEM and NCA, occurs because the symmetric method utilizes the mean score of the original variable for predictions, whereas NCA can assess the necessary factors that must exist to forecast the target outcome.

3.5. Ethical Considerations

All students participating in this study completed a consent form, ensuring voluntary participation. Research data are anonymous and will be used solely for research purposes. This research has received permission from Suryakancana University, Indonesia, with the following date: 5 March 2025 (Ref. No. 06a/LPPM/UNSUR/III/2025).

4. RESULT

During the reflective phase of PLS-SEM, the validity and reliability of variables were assessed through various computations. Cronbach's Alpha and Composite Reliability were used to evaluate reliability, while convergent and discriminant validity were assessed to determine validity. Table 2 presents the results of the validity and reliability analysis for each variable. The findings indicated that all variables demonstrated a relatively high level of validity and reliability. Additionally, the Heterotrait-Monotrait matrix was employed to examine the relationships between indicator items and other indicators. Table 3 displays the results of this analysis. The results showed that all variables exhibited strong discriminant validity. Subsequently, during the formative model analysis in the symmetric phase, metric integration was conducted to develop a conceptual model and address the research questions. This process included assessments of multicollinearity, path coefficients, t-values, the coefficient of determination (R^2), evaluations of direct and indirect effects, Stone-Geisser Q^2 values, Standardized Root Mean Square Residual (SRMR), and the Goodness of Fit (GoF) index.

Table 2. Results of the validity and reliability tests of the research constructs.

Variables	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Active learning	0.869	0.880	0.926	0.805
Behavioral engagement	0.816	0.830	0.890	0.730
Cognitive engagement	0.864	0.854	0.913	0.775
Constructive learning	0.892	0.898	0.934	0.832
Deep approach	0.842	0.840	0.897	0.750
Emotional engagement	0.860	0.865	0.915	0.782
Interactive learning	0.884	0.887	0.930	0.810
Passive learning	0.810	0.813	0.889	0.732
Surface approach	0.831	0.832	0.889	0.742

Table 3. Results of discriminant validity analysis.

Variables	AL	BE	CE	CL	DA	EE	IL	PL	SA
Active learning									
Behavioral engagement	0.283								
Cognitive engagement	0.486	0.713							
Constructive learning	0.410	0.489	0.631						
Deep approach	0.391	0.531	0.762	0.580					
Emotional engagement	0.320	0.782	0.626	0.706	0.508				
Interactive learning	0.289	0.590	0.590	0.551	0.535	0.752			
Passive learning	0.194	0.142	0.210	0.060	0.282	0.248	0.182		
Surface approach	0.197	0.662	0.780	0.483	0.550	0.483	0.442	0.135	

To facilitate the coding in the explanation of the analysis carried out, namely as follows: Active learning (AL), Passive learning (PL), Constructive learning (CL), Interactive learning (IL), Behavioral engagement (BE), Emotional engagement (EE), Cognitive engagement (CE), Deep approach (DA), Surface approach (SA). Furthermore, to assess multicollinearity, Variance Inflation Factor (VIF) analysis was used. Endogenous variables must have a VIF value of less than 5 to be able to perform multicollinearity analysis.

This value is in accordance with the current study so that the analysis can be carried out. Researchers answer the problem formulation based on the path coefficient value, t-value, and p-value. The results of the analysis on the bootstrap sample show that several findings of the variables mentioned have significant correlations, namely AL -> CE (β= 0.218), IL -> EE (β= 0.442), IL -> BE (β = 0.360), IL -> CE (β = 0.290), CL -> EE (β = 0.410), CL -> BE (β = 0.253), CL -> CE, CE -> DA (β = 0.563), CE -> SA (β = -0.515), and BE -> SA (β = -0.250). Apart from the variables mentioned, other variables do not show significant correlations because they have a t-value of less than 1.96 or have a p-value higher than 0.05.

The direct bootstrap analysis revealed that constructive and interactive learning significantly contributed to students' in-depth approaches to writing, with a value of (CL -> DA; β = 0.240); (IL -> DA; β = 0.232), and negatively created a surface approach, with a value of (CL -> SA; β = -0.220); (IL -> SA; β = -0.235). The results of the direct bootstrap analysis are presented in Table 4.

Table 4. Results of the direct bootstrap analysis.

β	2.5%	97.5%	t value	p value	Path
0.122	0.010	0.272	1.883	0.063	AL- > DA
-0.125	-0.263	0.018	1.770	0.082	AL- > SA
0.240	0.105	0.373	3.742	0.000	CL- > DA
-0.220	-0.372	-0.083	2.863	0.004	CL- > SA
0.232	0.104	0.342	3.725	0.000	IL- > DA
-0.235	-0.372	-0.082	3.342	0.001	IL- > SA
0.072	-0.064	0.180	1.073	0.292	PL- > DA
-0.052	-0.192	0.084	0.789	0.589	PL- > SA

Subsequently, a mediation analysis was performed to thoroughly examine the relationship among variables. Table 5 displays the findings of the mediation analysis. The analysis revealed seven positive correlations contributing to a deep approach among students, such as (AL- > CE- > DA; β = 0.120), (IL- > CE- > DA; β = 0.161), (CL- > CE- > DA; β = 0.180), while the negative surface approach included (IL- > BE- > SA; β = -0.092), (IL- > CE- > SA; β = -0.152), (CL- > CE- > SA; β = -0.172), and (AL- > CE- > SA; β = -0.113).

The researcher then used the coefficient of determination (R2) to analyze how well exogenous factors might predict the original variables. Strong, moderate, and weak predictive power are defined by the following criteria: 0.68 for strong prediction, 0.36 for moderate prediction, and 0.20 for weak prediction. The results of the predictive power analysis are shown in Table 6.

Thus, BE (0.31), CE (0.43), DA (0.44), EE (0.56), and SA (0.47), the results obtained from the analysis, show a satisfactory degree of predictive capacity. Subsequently, the model's accuracy was assessed by utilizing the Stone-Geisser (Q^2) values.

The model's fit index was evaluated concurrently with two measures. According to the analysis, the SRMR value was under 0.08 and the GOF attained 0.72. These values signify the optimal fit of the model.

Table 5. Results of the serial mediation analysis between variables.

Number	β	2.5%	97.5%	t-value	p-value	Path
1	-0.172	-0.312	-0.053	3.650	0.013	CL- > CE- > SA
2	-0.051	-0.152	0.052	0.840	0.512	PL- > CE- > SA
3	-0.152	-0.253	-0.050	3.882	0.005	IL- > CE- > SA
4	-0.113	-0.231	-0.020	3.162	0.042	AL- > CE- > SA
5	0.120	0.022	0.340	3.145	0.042	AL- > CE- > DA
6	0.161	0.052	0.389	3.552	0.015	IL- > CE- > DA
7	0.180	0.060	0.425	3.746	0.007	CL- > CE- > DA
8	0.047	-0.057	0.272	0.935	0.520	PL- > CE- > DA
9	-0.060	-0.162	-0.007	2.608	0.145	CL- > BE- > SA
10	-0.010	-0.085	0.050	0.370	0.892	PL- > BE- > SA
11	-0.092	-0.194	-0.035	3.104	0.040	IL- > BE- > SA
12	-0.014	-0.082	0.060	0.475	0.785	AL- > BE- > SA
13	0.009	-0.062	0.062	0.365	0.846	CL- > BE- > DA
14	0.002	-0.030	0.042	0.090	0.945	PL- > BE- > DA
15	0.013	-0.082	0.092	0.312	0.774	IL- > BE- > DA
16	0.003	-0.031	0.040	0.121	0.910	AL- > BE- > DA
17	0.008	-0.062	0.084	0.210	0.842	CL- > EE- > SA
18	0.003	-0.032	0.045	0.172	0.872	PL- > EE- > SA
19	0.008	-0.062	0.091	0.213	0.852	IL- > EE- > SA
20	0.000	-0.015	0.032	0.014	0.983	AL- > EE- > SA
21	0.052	-0.042	0.142	1.242	0.225	CL- > EE- > DA
22	0.017	-0.009	0.081	0.782	0.454	PL- > EE- > DA
23	0.054	-0.045	0.156	1.189	0.246	IL- > EE- > DA
24	-0.002	-0.030	0.042	0.062	0.972	AL- > EE- > DA

Active learning (AL), Passive learning (PL), Constructive learning (CL), Interactive learning (IL), Behavioral engagement (BE), Emotional engagement (EE), Cognitive engagement (CE), Deep approach (DA), Surface approach (SA).

Table 6. Results of structural model analysis.

Variables	Q^2	R^2
BE	0.193	0.314
CE	0.410	0.436
DA	0.382	0.442
EE	0.525	0.568
SA	0.431	0.472
GOF = 0.725		
SRMR = 0.06		

Subsequently, asymmetric conditional analysis (NCA) was employed to examine how ICAP learning designs, along with online engagement, influence immersive learning experiences via virtual media. NCA is regarded as very sensitive to the distribution's normality of the data. The findings of the data normality distribution analysis are presented in Table 7. Based on the analysis findings, the initial variable scores show a normal distribution with a value range from -2 to 2.

Furthermore, the display of the NCA analysis findings uses ceiling-envelopment-free because the precision of each definition reaches 100%. Based on the analysis findings, all variables contribute significantly to the development of immersive strategies for virtual exchanges in writing education, except for emotional engagement because the p-value exceeds 0.05. Based on the d-value classification, below 0.1 is considered small, the range of 0.1 to 0.3 is considered medium, and 0.3 to 0.5 is considered large, while values above 0.5 are considered very large.

According to the analysis outcomes in Table 8, each variable significantly influences the immersive method in the computer-guided writing education process. Additionally, eight factors can enhance students' deep involvement in virtual exchanges throughout the essay writing educational experience. To achieve a 50% in-depth engagement level, five criteria must be fulfilled: active learning should be at least 32%, behavioral engagement should be at least 21%, and cognitive engagement, interactive learning, and passive learning should all be at least 21%. The outcomes from both the symmetric and asymmetric analyses were combined to examine multiple scenarios. Multiple factors, including active and passive learning, are essential to promote students' profound comprehension of virtual exchanges.

Additional factors like constructive learning, interactive learning, behavioral engagement, and cognitive engagement can enhance the quality of students' deep involvement in virtual exchanges during writing instruction. Emotional engagement was the only variable that proved insignificant; thus, it was excluded from the analysis.

Table 7. Results of the normality distribution analysis of variables.

Latent variables' score	Mean	Observed min.	Observed max.	Excess kurtosis	Skewness
CL	0.000	− 1.940	2.189	− 1.030	0.152
EE	0.000	− 3.892	1.964	− 0.192	− 0.520
DA	0.000	− 3.784	3.274	0.032	− 0.536
BE	0.000	− 3.842	3.152	− 0.342	− 0.192
IL	0.000	− 3.324	1.882	− 0.768	− 0.062
PL	0.000	− 3.631	3.562	− 0.346	− 0.438
EG	0.000	− 3.537	3.053	− 0.967	− 0.387
AL	0.000	− 3.421	3.063	− 0.620	− 0.389

Table 8. Conditional analysis required on variables (NCA).

Variables	CE-FDH	p-value
AL	0.162	0.052
BE	0.212	0.042
CL	0.150	0.041
EE	0.187	0.136
CE	0.282	0.000
IL	0.173	0.052
PL	0.168	0.040

In addition to analyzing the process variables of the integration of virtual exchanges in computer-assisted writing learning in students' online engagement, deep approaches, and surface approaches, this study also investigated the impact of these interventions on the final outcome of essay writing competence. The results of descriptive data analysis are presented in Table 9 to determine the differences in the results of the intervention in the two groups. Based on the analysis results, all aspects of the experimental group's essay writing ability outperformed the control group, although some aspects were not significantly different. Overall, the intervention aspects of task achievement in cohesion, coherence, range and grammatical accuracy, and lexicon in essay writing in the experimental group were better than in the control group.

Furthermore, a one-way ANCOVA test was conducted to investigate significant differences between the experimental and control groups in improving essay writing skills. The results of the ANCOVA analysis of the overall essay writing skills of both groups, controlling for pretest scores, indicated a significant difference in the posttest scores. The experimental group demonstrated better writing skills than the control group, with a value of $F(1, 55) = 49.25$, $p < 0.00$, $\eta p^2 = 0.53$. The results of the ANCOVA analysis on essay writing skills are presented in Table 10.

Table 9. Results of the essay writing skills analysis in the pretest and posttest phases.

Aspect	Group	N	Mean	Std. deviation	Std. error mean
Pre-writing skills	Experiment	125	7.34	0.78	0.23
	Control	125	5.45	0.79	0.21
Post-writing skills	Experiment	125	8.35	1.12	0.22
	Control	125	6.32	1.03	0.21
Pre-task achievement	Experiment	125	5.36	0.84	0.17
	Control	125	4.42	0.85	0.17
Post-task achievement	Experiment	125	7.46	1.42	0.28
	Control	125	6.24	1.09	0.23
Pre-coherence and cohesion	Experiment	125	6.15	0.80	0.16
	Control	125	4.24	0.84	0.18
Post-coherence and cohesion	Experiment	125	7.32	0.83	0.15
	Control	125	5.83	1.08	0.23
Pre-lexicon	Experiment	125	5.37	1.07	0.21
	Control	125	4.42	1.42	0.28
Post-lexicon	Experiment	125	8.58	1.04	0.21
	Control	125	6.42	1.53	0.30
Pre-grammatical range and accuracy	Experiment	125	6.34	0.82	0.14
	Control	125	5.31	0.72	0.18
Post-grammatical range and accuracy aspect	Experiment	125	8.32	1.42	0.31
	Control	125	6.42	1.05	0.30

Table 10. Results of the ANCOVA analysis of differences in writing.

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Pre-writing performance	47.02	1	48.02	172.53	0.00	0.82
Groups	15.52	1	15.53	49.25	0.00	0.53

5. DISCUSSION

Verifying the factorial structure of interactive, constructive, active, and passive learning designs, as well as students' methods for engaging in online interaction and virtual interchange (whether deep or superficial), was the main goal of this study. The results enhance the current literature on online language learning. These results confirm the connections between factors influencing computer-assisted writing education and classify virtual exchange activities throughout the online writing learning experience (information sharing, comparative analysis, and collaborative tasks). Moreover, this research confirmed the categories of tasks in online education via virtual exchange: active, passive, interactive, and constructive. This discovery aligns with the knowledge transformation theory, suggesting that passive activities trigger the dynamic process of student involvement, resulting in active, interactive, and constructive learning. This passive learning plays a significant role in fostering students' in-depth approaches. This finding is further supported by previous studies, which revealed that the passive phase of the learning process is a receptive phase for developing students' knowledge (Dababneh, Margraf, Ayoub, Precht, & Brailovskaia, 2025; Khuder & Negretti, 2026). Furthermore, active learning was only able to predict students' cognitive engagement in virtual exchanges during online writing learning. This finding aligns with previous studies, which revealed that passive learning cannot encourage student engagement but can encourage students to use more cognitive effort (Holdinga et al., 2026; Zhang & Zhang, 2025). This finding is reinforced by other studies, which found that students' level of activeness in online learning is highly dependent on their perceptions of the relationship between real-life contexts and the learning material (Ng & Graham, 2026; Ten Peze et al., 2024).

Another finding is that interactive learning activities significantly influence online engagement. This explains that the level of student collaboration in virtual exchanges during writing learning significantly determines the level of knowledge required to write essays. Students construct knowledge from interactions with peers and from emotional, cognitive, and behavioral engagement during the online learning process. Therefore, students' online engagement will be higher when they construct knowledge collaboratively through information exchanges via virtual media. This result is consistent with earlier research, which showed that how often students engage in online learning

settings influences their academic success (Paulsen & Davidsen, 2025; Wang et al., 2025). Another observation is that interactive learning activities show greater shared variance in students' emotional involvement. This indicates that engaging activities during virtual exchanges can elicit more positive emotional responses from students. This occurs because the more intense their interactions with peers and students in virtual exchanges, the deeper the knowledge they gain (Shulgina et al., 2024; Tao et al., 2025). This finding adds an additional aspect of engagement to the literature that contributes to the interaction of virtual exchanges in writing learning (Bonnamy et al., 2024; Malpique et al., 2025). This finding complements previous findings that revealed the contribution of virtual exchanges to intercultural communication competence and digital skills (Ebrahimi & Ebadi, 2024; Taufiqulloh et al., 2025).

The next finding is based on an asymmetric analysis, which found that interactive learning tasks are essential in fostering students' in-depth approaches to the virtual exchange process. The contribution of these interactive tasks is direct because students must first reach agreement with their peers before developing new knowledge. Exchanging ideas with peers in virtual media can encourage interactive and constructive activities that ultimately lead to the development of new ways of thinking. This constructive learning is used when students are instructed to write essays individually, and they will write essays based on the results of their reflections. This constructive learning encourages students to achieve academic achievements from individual virtual exchanges (Ambreen, Ozdemir, & El-Dakhs, 2023; Peungcharoenkun & Waluyo, 2023). In addition, constructive learning also encourages students to ask questions and gain new knowledge and skills through the method of generating initiatives. This finding is in line with previous studies that revealed that the collaborative nature of virtual exchanges is key to success (Brydon et al., 2025; Chen & Huang, 2024). Based on the correlation findings, the collaborative nature, online engagement, and an in-depth approach play a significant role in building new knowledge in essay writing learning. These findings complement previous studies that revealed several aspects that contribute significantly to online learning, namely the frequency of use, the nature of collaboration, interaction methods, and the quality of integration of virtual exchanges into language instructional design (Ajabshir & Ebadi, 2023; Al-Mwzaiji & Alzubi, 2022). Therefore, individual, psychological, and contextual factors contribute to the success of computer-assisted language learning.

In addition to process analysis, this study also investigated the impact of integrating virtual exchanges into active, interactive, constructive, and passive learning designs on essay writing skills. The research findings indicate that the intervention significantly impacted essay writing skills. Improved essay writing skills were evident in the quality of writing, which met several aspects, including task achievement, cohesion, coherence, grammatical reach and accuracy, and vocabulary. Furthermore, learning to write through virtual media with active, interactive, constructive, and passive learning designs optimized behavioral, cognitive, and affective engagement. These findings align with activity theory, which states that various meaningful learning activities through technology will help students become independent learners (Rafi & Amjad, 2025; Varghese, 2025). Students who engaged in virtual exchanges were able to achieve a deeper level of engagement in writing more effectively and efficiently than students who learned through traditional learning. These findings align with previous studies that revealed that technology-assisted or online language learning can facilitate students' self-regulation compared to learning using conventional methods (Singh et al., 2024; Yakobi & Yakobi, 2025).

6. CONCLUSION, IMPLICATIONS, AND RECOMMENDATIONS

The integration of virtual exchanges into active, interactive, constructive, and passive learning designs has significantly impacted online engagement during the writing learning process. Through this online engagement, students are able to construct knowledge both individually and collaboratively. Active, interactive, constructive, and passive components encourage students to adopt an in-depth approach to the writing learning process, enabling them not only to acquire knowledge but also to develop new knowledge and utilize it in their essay writing. Furthermore, this intervention influences cognitive behavior and participation through various activities aimed at solving complex problems, thereby fostering in-depth virtual exchanges. Among all components of online engagement cognitive,

behavioral, and emotional cognitive and emotional engagement within these learning designs significantly impact students' in-depth approach to computer-assisted writing learning. Additionally, integrating virtual exchanges within these learning frameworks enhances essay writing skills more effectively than conventional methods. Improvements are evident in the quality of writing, which meets several criteria, including cohesion, coherence, lexical range, and grammatical accuracy. Moreover, writing learning with virtual exchanges optimizes students' behavioral, cognitive, and affective engagement. This study contributes to three theoretical frameworks of learning design: ICAP learning design in computer-assisted language learning, immersive approaches in virtual exchanges, and online engagement in virtual exchanges within computer-assisted language learning (CAL).

This study emphasizes the importance for instructors to focus not only on individuals and their cognitive abilities but also on collaboration and online engagement within the context of virtual exchanges. Instructors must be capable of integrating tasks that promote collaboration and individual involvement in computer-assisted virtual learning or AI technology to create constructive and active activities that enhance knowledge development. The study has several limitations, including its focus on university-level students and only involving the same study program. Additionally, the intervention duration is still short, gender variables are not considered in the analysis, and the focus is solely on writing skills as an output for measuring the effectiveness of the intervention. Furthermore, it does not comprehensively investigate the emotional engagement component. Based on these limitations, the researcher recommends several suggestions for future studies, such as expanding participants to include students from other study programs or high school levels, extending the duration of the intervention to achieve more optimal results, incorporating gender analysis for a comprehensive understanding, testing on other language skills like different types of writing or reading skills, and conducting a more thorough analysis of emotional involvement.

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REFERENCES

Ajabshir, Z. F., & Ebadi, S. (2023). The effects of automatic writing evaluation and teacher-focused feedback on CALF measures and overall quality of L2 writing across different genres. *Asian-Pacific Journal of Second and Foreign Language Education*, *8*(1), 26. https://doi.org/10.1186/s40862-023-00201-9

Al-Mwzaiji, K. N. A., & Alzubi, A. A. F. (2022). Online self-evaluation: The EFL writing skills in focus. *Asian-Pacific Journal of Second and Foreign Language Education*, *7*(1), 7. https://doi.org/10.1186/s40862-022-00135-8

Algouzi, S. I., & Hazaea, A. N. (2023). Emergency remote teaching practices: Discourse analysis of EFL writing communicative event. *Humanities and Social Sciences Communications*, *10*(1), 706. https://doi.org/10.1057/s41599-023-02195-8

Ambreen, F., Ozdemir, B., & El-Dakhs, D. A. S. (2023). Saudi undergraduate EFL learners' attitudes toward using textism in their academic writing. *Asian-Pacific Journal of Second and Foreign Language Education*, *8*(1), 38. https://doi.org/10.1186/s40862-023-00213-5

Bonnamy, J., Bugeja, L., Morphet, J., Russo, P. L., & Brand, G. (2024). Transforming researchers into writers through a series of semi-structured writing retreats: A mixed methods study. *BMC Nursing*, *23*(1), 611. https://doi.org/10.1186/s12912-024-02261-9

Brydon, C. C., Waitz-Kudla, S. N., Gomez, M., López, C. M., & Witte, T. K. (2025). Writing wrongs: Navigating microaggressions with adapted expressive writing for minoritized college students. *Journal of Racial and Ethnic Health Disparities*, 1-17. https://doi.org/10.1007/s40615-025-02560-0

Chan, A. (2008). *Teaching and learning in virtual environments*. London: Academic Press.

Chen, C.-M., & Huang, M.-Y. (2024). Enhancing programming learning performance through a Jigsaw collaborative learning method in a metaverse virtual space. *International Journal of STEM Education, 11*(1), 36. https://doi.org/10.1186/s40594-024-00495-2

Crook, K. M., Vega, H., Howell, E., Rowe, L. W., Bates, C. C., Mittapalli, K., & Banerjee, A. (2025). Responding to the needs of early literacy teachers: Designing online professional development to improve writing instruction for multilingual learners. *Early Childhood Education Journal*, 1-11. https://doi.org/10.1007/s10643-024-01841-3

Dababneh, N., Margraf, J., Ayoub, M. F., Precht, L.-M., & Brailovskaia, J. (2025). The effectiveness of online thematic expressive writing on prolonged grief disorder, anxiety, depression, and positive mental health among refugees in the transition stage of asylum seeking. *Journal of Immigrant and Minority Health*, 1-9. https://doi.org/10.1007/s10903-025-01778-8

Ebrahimi, B., & Ebadi, S. (2024). Exploring the impact of screencast-based ipsative assessment on EFL students' writing development. *Language Testing in Asia, 14*(1), 41. https://doi.org/10.1186/s40468-024-00315-y

Holdinga, L., van Drie, J., & Rijlaarsdam, G. (2026). Enhancing disciplinary literacy through integrated writing and process instruction: An intervention study. *Reading and Writing, 39*(1), 141-183. https://doi.org/10.1007/s11145-025-10630-2

Jin, S. (2025). Writing in the digital age: Understanding the relationship between social media use and college students' writing skills and anxiety. *Humanities and Social Sciences Communications, 12*(1), 1048. https://doi.org/10.1057/s41599-025-05443-1

Khuder, B., & Negretti, R. (2026). Collaborative writing regulation: A comparative case study of co-regulation and socially shared regulation in higher education. *Higher Education, 91*(2), 677–699. https://doi.org/10.1007/s10734-025-01437-9

Kiziltaş, Y., & Kultas, E. (2025). The effect of web 2.0 tools on primary school students' writing motivation and their role in developing creative writing skills. *Education and Information Technologies, 30*, 15993–16022. https://doi.org/10.1007/s10639-025-13419-6

Lee, C., & Chae, S. E. (2025). Enhancing teacher well-being through cognitive behavioral theory and visual imagery-based writing with the resulting tower model. *Scientific Reports, 15*(1), 2081. https://doi.org/10.1038/s41598-024-80997-9

Li, A. W., & Hebert, M. (2024). Unpacking an online peer-mediated and self-reflective revision process in second-language persuasive writing. *Reading and Writing, 37*(6), 1545-1573. https://doi.org/10.1007/s11145-023-10466-8

Lin, Y., & Yu, Z. (2025). Elucidating university students' intentions to seek automated writing feedback from Grammarly: Toward perceptual and systemic predictors. *Humanities and Social Sciences Communications, 12*(1), 7. https://doi.org/10.1057/s41599-024-03861-1

Liu, R., Xin, P., & Chen, K. (2025). The construction of authorial voice in thesis writing: A multidimensional comparative perspective. *Humanities and Social Sciences Communications, 12*(1), 737. https://doi.org/10.1057/s41599-025-04880-2

Malpique, A., Valcan, D., Pino-Pasternak, D., & Ledger, S. (2025). Teaching computer-based writing: Primary teachers' preparation, self-efficacy, and instructional practices. *The Australian Educational Researcher, 52*, 4555–4580. https://doi.org/10.1007/s13384-025-00910-9

Mekheimer, M. (2025). Generative AI-assisted feedback and EFL writing: A study on proficiency, revision frequency and writing quality. *Discover Education, 4*(1), 170. https://doi.org/10.1007/s44217-025-00602-7

Mogesse, A. T., Degefu, H. W., & Degaga, E. G. (2025). The effect of dialogue journal writing on Ethiopian first-year EFL students' writing anxiety and attitude: A quasi-experimental study. *Asian-Pacific Journal of Second and Foreign Language Education, 10*(1), 39. https://doi.org/10.1186/s40862-025-00349-6

Ng, C., & Graham, S. (2026). Teachers' goals for teaching writing to economically disadvantaged students: Relations with beliefs and writing instruction. *Reading and Writing, 39*(1), 1–28. https://doi.org/10.1007/s11145-025-10631-1

Paulsen, L., & Davidsen, J. (2025). Activity-based collaborative virtual reality: Conceptualising immersive virtual reality for collaborative learning. *International Journal of Computer-Supported Collaborative Learning, 20*, 317–341. https://doi.org/10.1007/s11412-025-09446-7

Peungcharoenkun, T., & Waluyo, B. (2023). Implementing process-genre approach, feedback, and technology in L2 writing in higher education. *Asian-Pacific Journal of Second and Foreign Language Education, 8*(1), 34. https://doi.org/10.1186/s40862-023-00211-7

Rafi, M. S., & Amjad, I. (2025). The role of generative AI in writing doctoral dissertation: Perceived opportunities, challenges, and facilitating strategies to promote human agency. *Discover Education, 4*(1), 165. https://doi.org/10.1007/s44217-025-00503-9

Reginald, G. (2023). Teaching and learning using virtual labs: Investigating the effects on students' self-regulation. *Cogent Education*, *10*(1), 2172308. https://doi.org/10.1080/2331186X.2023.2172308

Shulgina, G., Costley, J., Shcheglova, I., Zhang, H., & Sedova, N. (2024). Online peer editing: The influence of comments, tracked changes and perception of participation on students' writing performance. *Smart Learning Environments*, *11*(1), 30. https://doi.org/10.1186/s40561-024-00315-8

Singh, P., Murthy, V., Kumar, D., & Raval, S. (2024). A comprehensive review on application of drone, virtual reality and augmented reality with their application in dragline excavation monitoring in surface mines. *Geomatics, Natural Hazards and Risk*, *15*(1), 2327399. https://doi.org/10.1080/19475705.2024.2327399

Subandowo, D. (2024). An investigation of English academic writing strategies employed by Indonesian graduate students in a non-native English speaking environment. *Journal of English Language Studies*, *42*(1), 1–23.

Tao, L., Cukurova, M., & Song, Y. (2025). Learning analytics in immersive virtual learning environments: A systematic literature review. *Smart Learning Environments*, *12*(1), 43. https://doi.org/10.1186/s40561-025-00381-6

Taufiqulloh, T., Nindya, M. A., Sulistyawati, A. E., & Sumekto, D. R. (2025). Investigating Indonesian EFL students' writing strategies: A framework for self-assessment. *Language Testing in Asia*, *15*(1), 51. https://doi.org/10.1186/s40468-025-00388-3

Ten Peze, A., Janssen, T., Rijlaarsdam, G., & van Weijen, D. (2024). Instruction in creative and argumentative writing: Transfer and crossover effects on writing process and text quality. *Instructional Science*, *52*(3), 341-383. https://doi.org/10.1007/s11251-023-09647-3

Terkaj, W., Urgo, M., Kovács, P., Tóth, E., & Mondellini, M. (2024). A framework for virtual learning in industrial engineering education: Development of a reconfigurable virtual learning factory application. *Virtual Reality*, *28*(3), 148. https://doi.org/10.1007/s10055-024-01042-8

Usher, M., Roll, I., Fuhrman, O., & Amir, O. (2025). Supporting coordination and peer editing in students' online collaborative writing processes. *International Journal of Artificial Intelligence in Education*, *35*, 1504–1527. https://doi.org/10.1007/s40593-024-00450-w

Vallarino, M., Cersosimo, R., Torre, I., & Vercelli, G. (2025). Effects of using depth and motion in virtual reality to enhance language learning. *Virtual Reality*, *29*(3), 127. https://doi.org/10.1007/s10055-025-01203-3

Varghese, J. J. (2025). Writing without borders: AI and cross-cultural convergence in academic writing quality. *Journal of Academic Writing*, *34*(2), 1–11.

Wang, D., & Wang, J. (2025). The impact mechanism of AES on improving English writing achievement. *Scientific Reports*, *15*(1), 3928. https://doi.org/10.1038/s41598-025-88021-4

Wang, M., Dede, C., Grotzer, T. A., & Chen, J. (2025). Understanding and managing the complexities in situated learning in immersive virtual environments. *Educational Technology Research and Development*, *73*, 3177–3200. https://doi.org/10.1007/s11423-025-10519-5

Yakobi, K., & Yakobi, S. (2025). Online learning support as a pedagogical strategy for student learning in the developing universities in South Africa: A literature review. *Cogent Education*, *12*(1), 2464310. https://doi.org/10.1080/2331186X.2025.2464310

Zhang, J., & Zhang, L. J. (2025). Exploring the profiles of foreign language learners' writing self-regulation: Focusing on individual differences. *Reading and Writing*, *38*(6), 1533-1559. https://doi.org/10.1007/s11145-024-10568-x