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The Impact of Immersive Teaching Assisted by Spherical Video Virtual Reality (SVVR) with a Flipped Classroom Model on Argumentative Essay Writing Skills, Classroom Engagement, and Perceptions

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Abstract. Most students struggle to write argumentative essays due to a lack of schemata, so resources are needed to enrich them. The purpose of this study was to investigate the impact of SVVR-assisted immersive teaching using a flipped classroom model on argumentative essay writing skills, class engagement, and student perceptions. A quasi-experimental method was used, involving 200 university students majoring in Indonesian language education. The participants were divided into two groups with the same number of 100 students each: the experimental group received the intervention of spherical video virtual reality in a flipped classroom model, while the control group received conventional teaching. The instruments used were a rubric for assessing argumentative writing skills, a class engagement questionnaire, a rubric for assessing the lexical complexity of argumentative essays and interview questions. The data analysis included the Wilcoxon signed-rank test, the Quade test, paired-sample t-test, and one-way analysis of covariance (ANCOVA). The findings indicated that SVVR-assisted immersive teaching with a flipped classroom model improved argumentative essay writing skills, class engagement, and student perceptions. Improved argumentative writing skills were evident in the use of evidence and data to support arguments, which were presented more robustly and scientifically, resulting from the observation of objects. Improvements in the quality of argumentative essays were also evident in the increased lexical complexity across all aspects of lexical density, lexical sophistication, and lexical variety. Increased class engagement was evident in cognitive

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engagement, behavioral engagement, and emotional engagement. Positive perceptions were evident in the experience, emotion, active motivation, and strategies used for improving writing learning. Thus, improvements in all competencies occurred because the intervention enhanced realistic and context-rich experiences, critical thinking skills, and evidence-based reasoning. This research suggests that the use of virtual reality technology can enhance the students' understanding of difficult concepts and create positive impressions of the learning process.

Keywords: Immersive Teaching; Spherical Video Virtual Reality (SVVR); Flipped Classroom Model; Writing Skills; Argumentative Essay

1. Introduction

Writing competency serves as a basic foundation for producing other scientific papers, which are essential at the tertiary level (Yang & Pan, 2023; Zhang, 2023). However, most students still struggle to write argumentative essays due to their inability to organize their ideas or their lack of understanding of what to write. To address this issue, media that can facilitate the students' understanding and organization of their ideas is needed. Several previous studies have shown that immersive virtual reality (VR) teaching, which presents various natural phenomena and other content in the classroom, can facilitate students' argumentative writing skills (Phi & Pham, 2021; Tseronis, 2021). Immersive learning is currently widely used, utilizing various virtual technology aids in teaching to optimize language competency (Huang et al., 2019; Pfeifer & Fermüller, 2023).

One such approach is Spherical Video Virtual Reality (SVVR), which is considered to be effective at improving argumentative writing skills, classroom engagement, and perceptions because it can enhance the students' understanding of abstract or complex concepts (Castagna et al., 2025; Steiss & Chung, 2023). Spherical video virtual reality (SVVR) is a technology that uses a 3D graphics system with various interactive interfaces. This creates immersive and interactive learning in a 360-degree viewing environment, to increase classroom engagement and positive perceptions. Immersive learning with the help of SVVR technology has been proven effective at improving cognitive efficiency in the processing of complex and abstract information (Backman et al., 2023; Bernal-Ballen, 2024).

Several previous studies have shown that SVVR can improve conceptual understanding, academic writing achievement, and problem-solving (Ackermann & Siegfried, 2022; Allcoat et al., 2021). Although several previous studies have explored the impact of SVVR use, there is still a research gap regarding the exploration of its use with instructional approaches, such as argumentation. Argument activities in the learning process will help develop the conceptual understanding of the writing content, as well as teaching strategies, critical thinking, and argumentative writing (Habeb et al., 2025; Imsa-ard, 2025). Therefore, argumentation activities are an effective instructional approach in improving understanding of the writing content while also improving argumentative essay writing competency. However, this approach has obstacles

and challenges such as uninteresting topics, insufficient time, limited discussion opportunities, and minimal knowledge for argumentation (Anggraeni et al., 2025; Rahimivand et al., 2025). To overcome these challenges, this study used a flipped classroom in its intervention process. By using the flipped classroom model, students are facilitated to learn the material first through virtual media, to explore the content, and to engage in collaborative activities with guidance (Mallahi, 2024; Ten Peze et al., 2024). The flipped classroom learning model has been shown to improve critical thinking and problem-solving, as well as learning performance, motivation, and time efficiency. The combination of SVVR and flipped classroom is believed to significantly improve argumentative writing skills.

Previous studies have shown that SVVR technology can improve descriptive writing skills and writing motivation. Furthermore, other studies have shown that immersive learning with AR can enhance the understanding of complex and abstract content and materials, as well as classroom engagement and positive perceptions (Cuevas et al., 2024; Rahimi et al., 2024). These findings confirm that virtual technology can facilitate the learners' comprehensive understanding of the material. A comprehensive understanding of this concept significantly contributes to the quality of student argumentation (Wu & Peng, 2024; H. Yang et al., 2022).

Previous studies have confirmed that AR-based teaching and flipped classrooms can improve the ability to write observational reports at the tertiary level (Phi & Pham, 2021; Tseronis, 2021). Other studies have confirmed that the quality of the learners' argumentation improves with the combination of SVVR with collaboration and discussion methods to deepen the writing topic and material (Kerman et al., 2024; Osawa, 2025). The current research differs from previous studies. The novelty of this study is that it uses immersive learning with the assistance of spherical video virtual reality (SVVR) technology combined with the flipped classroom to achieve optimal learning outcomes.

Furthermore, the targeted competencies are more comprehensive, namely argumentative essay writing skills and cognitive engagement during the writing learning process. Thus, the main focus of this study is to investigate the impact of immersive learning with the assistance of spherical video virtual reality (SVVR) technology combined with the flipped classroom regarding the students' argumentative essay writing skills, class engagement, and perceptions. Based on this explanation, the researchers formulated the following research questions:

a) How does immersive instruction utilize spherical video virtual reality (SVVR) technology within a flipped classroom model impact/affect argumentative essay writing skill?
b) What is the impact of immersive instruction using spherical video virtual reality (SVVR) technology within a flipped classroom model on student engagement (cognitive, behavioral, and emotional)?
c) What is the impact of immersive instruction using spherical video virtual reality (SVVR) technology within a flipped classroom model on student perceptions?

2. Literature Review

2.1 Argumentative Essay Writing Skills, Class Engagement, and Perceptions

Argumentation is the act of verbally presenting a particular viewpoint with strong reasoning. College students are highly dependent on this skill. Argumentation skills are essential for writing scientific papers. Some essential core competencies for college students include argumentation, the use of claims and evidence, and critical thinking skills (Ke, 2025; Lertvittayakumjorn & Toni, 2023). Integrating argumentation into writing lessons can encourage learners to improve their critical thinking skills, cognitive engagement, and the development of sociocultural perspectives through text comprehension (Huang et al., 2024; Latifi et al., 2021).

Several previous studies confirm that argumentation skills can be enhanced through online collaborative learning (Bernal-Ballen, 2024; Steiss & Chung, 2023). These learning environments do not encourage immersive learning experiences and are not optimal for facilitating conceptual understanding, particularly of complex and abstract concepts, and situational awareness (Arts et al., 2024; Backman et al., 2023). Argumentative writing requires critical thinking and self-regulation to meet the assignment requirements. Argumentative writing encourages learners to evaluate claims and analyze data to support their written ideas. Success in the writing learning process can also be seen from class involvement and the student perceptions of the learning process. Class engagement refers to student participation in every aspect of the essay writing learning process. Class engagement encompasses the cognitive, affective, and emotional dimensions.

Class engagement is largely determined by the media and learning model used, ensuring that all learners actively develop their writing knowledge and competencies (Anggraeni et al., 2025; Rahimivand et al., 2025). The student perception of the learning process refers to their perspective of the learning process they have undergone. This perception is shaped by the learning environment and its perceived impact. Student perceptions of the argumentative essay writing process can highlight the methods and media used during the learning process, the role of the instructor, and the perceived benefits to their argumentative essay writing skills (Mallahi, 2024; Ten Peze et al., 2024).

2.2 Spherical Video-Based Virtual Reality (SVVR)

Spherical Video-Based Virtual Reality (SVVR) is a learning medium that facilitates learners in observing objects, concepts, or content in an immersive 360-degree environment. This medium is considered innovative and cost-effective (Cauz et al., 2024; Ironsi, 2023). It encourages learners to engage more actively in a realistic virtual learning environment. SVVR technology also has potential in language learning because it enhances the understanding of concepts, materials, or objects, improves problem-solving skills, and enhances cognitive engagement (Khodabandeh et al., 2025; Yang et al., 2023).

Previous studies have confirmed that SVVR integration can help learners understand concepts more comprehensively and intuitively, enabling them to better organize their ideas into descriptive essays (Dudley et al., 2023; Li et al., 2025). Other studies have shown that SVVR technology can contribute to the quality of the learning process, as well as collaboration, and interaction during writing (Chen et al., 2023). These findings suggest that integrating SVVR technology into writing learning not only improves writing skills but also facilitates a more meaningful and in-depth learning experience. Although SVVR technology has significantly impacted writing competency, argumentative writing instruction will not be optimal if the students lack sufficient knowledge of the content they will be writing about. This limited knowledge will undoubtedly impact the students' participation in critical discussions and the quality of their arguments, given the limited classroom time (Chen et al., 2023; Dudley et al., 2023).

2.3 The Flipped Classroom Approach To Writing Instruction

The flipped classroom approach provides students with the opportunity to learn the material first before the actual instruction takes place in class. This flipped classroom model emphasizes flexibility in the learning environment and instructional design, and places the learner in the central role (Phi & Pham, 2021; Wang et al., 2025). The writing instruction using the flipped classroom model positions the instructor as the scenario director, with the learner as the primary actor exploring the learning material outside of class. The flipped classroom model has several key components: meaningful assignments, teacher role transformation, quality instruction and interactions, holistic learning, rapid feedback, and technology integration (Kerman et al., 2024; Osawa, 2025).

In the flipped classroom approach, instructions can be delivered through an online platform and offers flexible access opportunities at one's own pace. Previous studies have shown that the flipped classroom approach contributes to the depth of argumentation (Haro et al., 2024; Latifi et al., 2021). The integration of SVVR technology and the flipped classroom into writing instruction means that the learners are better prepared and able to reflect on the immersive content, thus facilitating deeper learning. The flipped classroom uses pre-recorded videos before class to facilitate the learners' cognitive management. With the flipped classroom approach, learners manage their cognition by pausing, rewinding, speeding up, and slowing down the video.

3. Methodology

3.1 Participants and the Research Design

This study used a quasi-experimental pre-test-post-test control group design to test the impact of immersive learning supported by spherical video virtual reality (SVVR) in a flipped classroom model on the students' argumentative writing skills, cognitive engagement, and perceptions. This study involved 200 university students who were in their second to sixth semesters aged 19-22 years old. Sampling was done randomly because they had the same level of ability for writing argumentative essays as determined through a pretest. The participants were divided into two groups, with each group consisting of 100 students. The

experimental group received a spherical video virtual reality (SVVR)-assisted argumentative writing learning intervention using a flipped classroom model, while the control group received a conventional teaching intervention. Prior to the intervention, all participants completed a consent form, indicating their voluntary participation. Both groups received the same learning materials, and the lessons were of the same duration. The only difference was the teaching intervention.

3.2 Research Instrument

3.2.1 Argumentary Writing Skills Assessment

Argumentary writing skills were assessed using an argumentative essay assessment rubric. This rubric covers the four components of the Toulmin argumentation pattern (claim, evidence, warrant, and support) and is scored on a scale of 0 to 3 points. The assessment was conducted by two raters who are experts in argumentative texts. Scoring was conducted independently, and all raters discussed the determination of the scores for each Toulmin dimension, which was used for the final analysis.

Based on the analysis, the Cohen's Kappa values of the two raters in the pretest and posttest phases of the control and experimental groups ranged between 0.72 and 0.82. These results indicate substantial agreement among the raters in determining the scores for argumentative writing skills. The argumentative writing test used themes such as natural phenomena such as volcanic eruptions and tsunamis, the environment and survival of wild animals, and the social environment of elite housing and community settlements.

3.2.2 Class Engagement Questionnaire

To assess the students' classroom and cognitive engagement, the researchers used a class engagement questionnaire. This questionnaire includes 27 items that assess the three components of classroom engagement of behavioral engagement, cognitive engagement, and emotional engagement. Each component consists of 10 statements assessing behavioral engagement, seven statements assessing cognitive engagement, and 10 items assessing emotional engagement.

All components were measured using a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The analysis showed Cronbach's Alpha value for the three components as a whole of 0.78, while Cronbach's Alpha values for behavioral engagement, cognitive engagement, and emotional engagement were 0.82, 0.80, and 0.80, respectively. These values indicate that the questionnaire has high reliability, meeting the criteria and allowing it to be used in research.

3.2.3 Assessing the Lexical Complexity of Argumentative Essays

The metrics for assessing the lexical complexity of argumentative essays were adapted. The complexity dimension relates to lexical richness, complexity, and vocabulary variety. Lexical density is evaluated by comparing the number of lexical words to the total number of words. Lexical sophistication is measured by comparing the number of sophisticated lexical terms to the total number of lexical terms. Furthermore, lexical diversity is evaluated based on the proportion of tokens of the adjusted type. The complexity analysis was assessed using the Lexical Complexity Analyzer application.

3.2.4 Semi-Structured Interviews

The students' perceptions of the intervention were explored through in-person semi-structured interviews. Ten participants were randomly selected from the experimental group. Each student's interview session lasted 20 minutes and was recorded for analysis. Some examples of questions from the interviews were: "How does the impact of SVVR technology compare with conventional teaching on understanding complex concepts, for example, the process of a volcanic eruption?" "How does SVVR impact your confidence in participating in discussions?" and "How can this teaching method visualize and understand concepts in writing argumentative essays?" The interviews were transcribed and analyzed using thematic analysis. The analysis of the interview results regarding student perceptions of the intervention were divided into several categories, specifically learning experiences, the role of emotions and active motivation, and learning improvement strategies.

3.3 Procedure

This study was conducted over six weeks, with three weekly sessions lasting 55 minutes. The intervention design for the teaching of argumentative writing using SVVR technology within the flipped classroom model is based on constructivist theory and actively involves the learners. To facilitate the flipped classroom model, several platforms were used, including YouTube, Google Drive, PowerPoint, and the Uptale platform. The interventions in experimental and control groups were carried out using the same steps as shown in Table 1. The only difference between the interventions of the two groups was the media used. The experimental group used SVVR and other media such as YouTube, Google Drive, and PowerPoint, while the control group only used the lecture method and PowerPoint. The intervention stages are described in Table 1.

Table 1: Stages of SVVR-assisted immersive teaching with the flipped classroom model

Steps	Explanation
1	Before each writing session in class, all students are given the opportunity to study the material outside of class using various resources such as YouTube, Google Drive, PowerPoint, and the Uptale platform. Assignment instructions are provided through the Learning Management System (LMS) platform, which all students can access.
2	After gaining sufficient knowledge, the writing lesson in class begins with an explanation of the concept of argumentative writing and its structure, along with a sample argumentative essay, which is discussed in detail. During the class phase, students are given the opportunity to ask questions or discuss their learning outcomes from the pre-class.
3	Students receive an explanation of the SVVR feature and are provided with content that will be developed into argumentative essays. The argumentative essay topics include natural phenomena such as volcanic eruptions and the process of tsunamis; the environment and survival of wild animals; and the social environment of elite housing and community settlements.
4	Students have the opportunity to view three videos on these themes through SVVR and the Uptale immersive learning platform. Students also receive an interactive VR experience using 360° capture through SVVR technology.

5	Students are given the opportunity to engage in discussions after observing the objects that will be used in their argumentative essays. This discussion opportunity serves to strengthen their understanding in developing strong claims and reasons to support their ideas.
6	Students have the opportunity to write argumentative essays under the guidance of their instructors.
7	The instructor and students discuss and evaluate the argumentative essays they have created as practice material.
8	Students are assigned to create an argumentative essay accompanied by a PowerPoint presentation that can be explained in class.
9	Students are provided with online platforms that can be accessed outside of class to strengthen their understanding of the argumentative essay concept and the content they will develop, using various platforms such as YouTube, Google Drive, PowerPoint, and the Uptale platform.
10	Students present their argumentative essays, accompanied by explanatory PowerPoint presentations.
11	The instructor provides feedback on strengths and weaknesses, allowing students to self-evaluate and demonstrate improved performance.

3.4 Data Analysis

The research results were analyzed using quantitative and qualitative data analysis. The Shapiro–Wilk test was used to test for normality. The Wilcoxon signed-rank test and the Quade test were used to analyze the argumentative writing ability data. The paired-sample t-test and one-way analysis of covariance (ANCOVA) were used to investigate significant differences between the groups. Next, the interview data was transcribed and analyzed using thematic analysis. A structured approach is essential for obtaining meaningful findings from the interview analysis. The results of this analysis regarding the key themes and subthemes provide a comprehensive explanation of the students' perspectives on the intervention.

4. Result

4.1 Impact of the Intervention on Argumentative Essay Writing Skills

To answer the first research question, within-group and between-group analyses were conducted to investigate the impact of the intervention on argumentative essay writing ability. First, within-group analysis was conducted on the content of the students' writing during the pretest and posttest stages. The Wilcoxon signed rank test was conducted to investigate the argumentative writing ability in the pretest and posttest phases of both groups. The results of the Wilcoxon signed rank in both groups are presented in Table 2. The results of the analysis show that there was a significant increase in the ability to write argumentative essays from the pretest to the posttest phase with a value of ($z = -2.53$, $p = 0.04$, $r = 0.82$).

However, in the control group, there was no significant difference in the ability to write argumentative essays in the pretest and posttest phases with a value of ($z = -1.79$, $p = 0.08$, $r = 0.70$). These findings indicate that the immersive teaching intervention assisted by SVVR technology with a flipped classroom model is able to improve the ability to write argumentative essays more significantly than the conventional writing teaching intervention. Next, an intergroup analysis was

conducted to compare the ability to write argumentative essays between the two groups. The ANCOVA test was conducted in the intergroup analysis to assess the ability to write argumentative essays. The results of the ANCOVA analysis are presented in Table 3. The analysis showed a significant difference in the argumentative essay writing skills of the two groups ($F = 0.19$, $p < 0.05$). This finding indicates that the use of SVVR technology significantly contributed to argumentative essay writing skills compared to conventional teaching alone.

Table 2: Results of the Wilcoxon signed-rank test for argumentative writing skills

Group		*N*	Mean	*SD*	Wilcoxon *W*	*z*	*p*	*R*
Control	Pretest	100	8.42	1.40	21.04	− 1.79	0.08	.70
	Posttest	100	9.24	1.62				
Experimental	Pretest	100	8.52	1.48	35.12	− 2.53**	0.04	.82
	Posttest	100	14.21	0.93				

Table 3: Inter-subject effect test on the ability to write argumentative essays

Dependent variable: unstandardized residual					
Source	Type III sum of squares	*df*	Mean square	*F*	*P*
Corrected model	.592[a]	1	.621	.190	.003
Intercept	.010	1	.010	.004	.962
Group	.634	1	.593	.183	.635
Error	46.435	198	3.421		
Total	47.083	*200*			
Corrected total	47.083	*200*			

a $R2 = .013$ (adjusted $R2 = -.058$)

Next, the analysis of lexical complexity in the argumentative essays was conducted using the ANOVA test. The results of the lexical complexity analysis are presented in Table 4. The results of the analysis show that both groups showed an increase in lexical complexity, but the lexical complexity of the experimental group's argumentative essays was more significant than the control group. The analysis of lexical complexity includes lexical density, lexical sophistication, and lexical variation. The results of the analysis show that immersive teaching assisted by SVVR, and the flipped classroom model has a significant main effect of time on lexical density with $F (2, 73) = 18.436$, $p < 0.001$, and Partial $\eta 2 = 0.568$. The main effect of group was also quite significant, with a value of $F (1, 68) = 0.142$, $p = 0.746$, Partial $\eta 2 = 0.003$.

There was a significant interaction effect between time and group with a value of $F (2, 73) = 0.182$, $p = 0.842$, Partial $\eta 2 = 0.008$. The results of the pairwise analysis found that both groups showed an increase in lexical density, with the experimental group showing better improvement in each phase. The results of the analysis on the lexical sophistication aspect showed that there was a significant main effect due to the time variable with a value of $F (2, 73) = 107.574$, $p < 0.001$, Partial $\eta 2 = 0.745$. In addition, the main effect of group was found to have a value of $F (1, 60) = 5.025$, $p = 0.064$, $\eta 2$ Partial $= 0.083$ and there was a significant interaction effect between time and group with a value of $F (2, 73) = 0.001$, $p =$

0.836, η2 Partial = 0.001. The next analysis was a mixed ANOVA test on lexical variation. The results of the analysis showed that there was a significant main effect due to the time variable with a value of F (2, 73) = 22.042, p < 0.001, η2 Partial = 0.536. In addition, a significant main effect of group was found with an F (1, 60) value of 8.246, p = 0.010, Partial η2 = 0.112, and a moderately significant interaction effect between time and group with an F (2, 73) value of 6.547, p = 0.008, Partial η2 = 0.183 on lexical variation performance in the students' writing.

Table 4: Descriptive statistics for lexical complexity

Lexical complexity	Group	*N*	Pre-test		Post-test		Delayed posttest	
			M	*SD*	*M*	*SD*	*M*	*SD*
lexical density	Experiment	100	4.637	.043	8.365	.032	8.365	.047
	Control	100	4.538	.045	5.470	.048	5.382	.032
lexical sophistication	Experiment	100	4.125	.052	8.254	.042	8.536	.050
	Control	100	4.356	.044	5.682	.046	5.462	.052
lexical variation	Experiment	100	4.642	.457	7.536	.652	8.562	.436
	Control	100	4.568	.482	5.683	.546	5.683	.372

4.2 Impact of the Intervention on Class Engagement

The next analysis is of student class engagement during the intervention process in both groups. For a more detailed analysis of student classroom engagement during the intervention process, an ANCOVA test was conducted. The results of the ANCOVA test on student classroom engagement are presented in Table 5. This test was conducted to investigate the comparison of the posttest scores of the two groups, using the pretest scores as a covariate. Levene's test was used to investigate the homogeneity of variance between the pretest and posttest scores.

The analysis showed significant differences in the variance of overall classroom engagement and each of its aspects. The overall classroom engagement score was (F = 3.542, p = 0.034), while the scores for each aspect of engagement, namely behavioral engagement (F = 4.275, p = 0.025), cognitive engagement (F = 4.447, p = 0.046), and emotional engagement (F = 3.268, p = 0.024), significantly increased. These findings indicate that the immersive teaching intervention supported by SVVR and the flipped classroom model was able to improve overall classroom engagement and each of its aspects.

Table 5: ANCOVA test results for student classroom engagement

Variable	Group	*N*	Mean	*SD*	Adjusted mean	*SE*	*F*	*p*	η2
Overall classroom engagement	Experimental	100	7.74	0.46	3.61	0.07	3.542	0.034	0.036
	Control	100	3.68	0.52	3.73	0.07			
Behavioral engagement	Experimental	100	6.58	0.41	3.58	0.05	4.275	0.025	0.046
	Control	100	3.60	0.45	3.70	0.06			
Cognitive engagement	Experimental	100	8.46	0.52	3.46	0.07			
	Control	100	3.46	0.62	3.63	0.08	4.447	0.046	0.053
Emotional engagement	Experimental	100	3.46	0.60	3.72	0.07			
	Control	100	6.48	0.71	3.62	0.08	3.268	0.024	0.048

4.3 Impact of the Intervention on Perceptions

Next, the analysis of the interview results regarding perceptions is presented based on several main themes, namely the experience of learning, the role of emotions, active encouragement, and strategies for improving writing learning. Ten students in the experimental group were selected to explore the students' perceptions of the intervention in the experimental group. The analysis focused on the first theme, namely teaching and learning to write arguments. The interview results showed that students in the experimental group who received the SVVR technology intervention had a positive perception of the intervention in relation to the argumentative writing learning process.

Several students stated that SVVR's interactive features, such as 360-degree observation, background music, and chairs, were able to facilitate them in understanding the writing concepts and materials comprehensively. In addition, the SVVR feature was also able to visualize objects of argumentative writing realistically. Here are some interview excerpts highlighting the interactive features of SVVR:

> "*Through SVVR technology, I was able to learn the material directly by observing the object I was writing about with a 360-degree view, which made me feel as if I were there. This observation process gave me ideas for writing argumentative essays, explaining the object in great detail (P3).*"

> "*Reading, watching videos, taking quizzes, and exploring natural phenomena in the SVVR feature made learning more engaging and easier to understand. Furthermore, this process gave me more ideas to support my claims with various pieces of evidence from observing the object I was writing about (P7).*"

The next theme in the interview analysis was the role of emotions in the argumentative writing learning process. The interview analysis revealed that students who received the SVVR technology intervention expressed that the use of SVVR provided enjoyment in learning and facilitated problem-solving in an

engaging and enjoyable way. Below are some of the interview excerpts that reveal the role of emotions in the intervention process.

> "*I became more enthusiastic when I was given the opportunity to discuss with my group members and exchange ideas to support my claims using various arguments from observations using SVVR technology (P9).*"

> "*The flipped classroom model gave me the opportunity to learn the content and materials before class. This phase made me more confident in participating in class during the argumentative writing process (P2).*"

The next theme was encouraging active participation in class. Students assessed the immersive teaching process, supported by SVVR technology and the flipped classroom model, as encouraging them to develop their argumentative skills and collaborate with their peers to deepen their arguments. Several students revealed that collaboration in constructing arguments helped them analyze the problems and identify relevant information to support their arguments. Here are some quotes from students in the experimental group:

> *"In argumentative essay writing practice, for example, on the topic of volcanic eruptions, we were asked to support claims with various pieces of evidence. Through SVVR, I detailed the volcanic eruption and the affected areas, providing me with numerous supporting arguments (P6)."*

> *"The discussion process during the learning process facilitated students in expressing and clarifying various pieces of evidence, evaluating and strengthening the components of their arguments by providing feedback to one another (P8)."*

The SVVR feature and the stages of the argumentative essay writing learning process generally encouraged the students to actively participate in the learning process. This encouragement of active participation indirectly contributed to the students' argumentative essay writing skills. The final theme of the interview analysis was strategies for improving learning. The interviews revealed several statements that revealed the strategies and features of interventions that could enhance the effectiveness of immersive teaching using SVVR and the flipped classroom model related to argumentative essay writing skills.

Furthermore, several students offered suggestions for improving the effectiveness of the argumentative essay writing learning process. Below are some excerpts from the statements highlighting aspects that can enhance the effectiveness of the learning process.

> *"The 360-degree videos, images, and virtual reality materials made the learning more engaging and more effective in expanding my schema regarding the topics I will use in writing argumentative essays (P10)."*

> "*The discussion phase and the flipped classroom model improved my learning strategies for understanding the content and materials. My understanding of the material and writing content before class began was already very solid, so I felt more confident participating in class (P4).*"

Students highlighted the features of SVVR and the flipped classroom model, which facilitated a more comprehensive understanding of the material and content for the argumentative writing. The findings suggest that the students' perceptions of all aspects of the intervention were positive in helping them improve their argumentative essay writing skills, including its contribution to the argumentative writing learning experience, the role of emotions in the writing learning process, active encouragement in the writing learning process, and strategies for improving writing learning.

5. Discussion

This study aimed to investigate the impact of an immersive teaching intervention supported by the use of spherical video virtual reality (SVVR) within the flipped classroom model on argumentative essay writing skills, cognitive engagement, and perception. The first research finding shows that immersive teaching interventions assisted by the use of spherical video virtual reality (SVVR) with a flipped classroom model can significantly improve argumentative essay writing skills compared to conventional teaching. Improved argumentative writing skills are evident in the use of evidence and data to support arguments presented more strongly and scientifically, resulting from object observations.

In addition, the improvement in the quality of argumentative essays is also evident in the increased lexical complexity according to lexical density, lexical sophistication, and lexical variety. This improvement occurs because SVVR technology is able to provide a VR learning environment that facilitates the students in learning the material better and more comprehensively than relying solely on verbal explanations. This finding is reinforced by previous studies that show that virtual reality environments in the learning process contribute significantly to writing skills because they are able to facilitate the understanding of abstract and complex concepts (Anggraeni et al., 2025; Yang et al., 2023).

This finding is also reinforced by other studies that show that the use of AR technology can improve the understanding of objects more comprehensively, thus contributing significantly to descriptive writing skills (Cuevas et al., 2024; Ironsi, 2023). In addition, other studies also confirm that the flipped classroom approach in language learning strengthens student understanding and schemata so then they are more prepared and confident to participate in class (Chen & Zhang, 2025; Tseronis, 2021). The interview findings also indicated that the use of SVVR technology facilitated the students' access to supporting evidence in a virtual environment, thus strengthening their arguments. The use of SVVR encouraged students to think critically and provide strong evidence to convince their peers during discussions and in their argumentative writing.

This improvement in argumentative skills occurred due to the integration of immersive virtual reality simulations with the flipped classroom model, which facilitated the students' deeper understanding of the writing materials on natural phenomena and other topics. The improvement in argumentative writing skills was also due to several interconnected dimensions, such as an understanding of the nature of scientific disciplines, research methods, critical thinking skills, and

existing knowledge. The use of immersive SVVR technology helped the students construct arguments and reduced the cognitive load, making the interventions more effective at improving argumentative writing skills. These findings are supported by previous studies showing that argumentative writing can be strengthened by understanding the content of the writing material through immersive virtual reality instruction (Cuevas et al., 2024; Ten Peze et al., 2024). This is further supported by learning theory, which suggests that the understanding of the learning materials and concepts is more optimal when combined with visual reality media and independent learning or a flipped classroom (Ironsi, 2023; C. Yang et al., 2023).

The next finding is that the immersive teaching intervention assisted by SVVR with a flipped classroom model is able to increase student class engagement in the aspects of behavioral engagement, cognitive engagement, and emotional engagement. From the analysis results, the most significant increase was in student cognitive engagement, followed by behavioral and emotional engagement. This condition occurs because SVVR-assisted writing instruction is able to encourage higher cognitive processing compared to conventional teaching. SVVR media that provides students with the opportunity to observe objects and interact with writing objects in reality can encourage the students' cognitive processes more intensively. This discussion phase also contributes to behavioral and emotional engagement when arguing.

All of these processes contribute to cognitive, behavioral, and emotional engagement. This finding is reinforced by previous studies showing that AR-assisted teaching that makes students feel as if they are in a location will encourage involvement in all aspects of the learning process, namely cognitive, behavioral, and emotional (Khodabandeh et al., 2025; Mansour et al., 2025). This study also confirms the previous research showing that the use of virtual media can expand students' schemata, encouraging them to participate more actively in both cognitive and non-cognitive activities at each stage of learning (M. Chen et al., 2023; Mansour et al., 2025). This finding is further reinforced by previous research showing that SVVR technology is more effective when used in practical language learning rather than to simply explain concepts (Anggraeni et al., 2025; Peltzer et al., 2025).

The next finding is that the results of the interview analysis generally indicate a positive perception of the intervention using SVVR and the flipped classroom model as part of learning to write argumentative essays on each theme analyzed. Positive perceptions are evident for each analysis theme, namely the experience of learning to write argumentatively, the role of emotions in the writing learning process, active encouragement in the writing learning process, and strategies for improving writing learning. The formation of these positive perceptions occurs due to the features of SVVR technology and the flipped classroom, such as videos, 360-degree images, quizzes, feedback, discussions, and the flipped classroom itself.

All of these features facilitate the students in observing the writing objects directly, such as observing the process of volcanic eruptions, tsunamis, and other themes directly. In addition, the discussion and feedback stages also encourage students to engage cognitively, behaviorally, and emotionally. This finding is in line with the theory that a language learning process that optimizes participation cognitively, emotionally, and behaviorally will create positive impressions and perceptions of the learning process (Kerman et al., 2024; Phi & Pham, 2021).

Positive perceptions in the language learning process arise because of the contribution of writing learning to the acquired competencies and the enjoyable learning process itself (Ackermann & Siegfried, 2022; Imsa-ard, 2025). These findings are further supported by previous studies, which show that the use of virtual reality learning environments can foster a positive learning experience because learners are made to feel as if they are at the learning location (Arts et al., 2024; Backman et al., 2023). This process, in addition to providing a positive virtual experience, can also generate better cognitive responses, thus significantly contributing to language competence.

6. Conclusion

Immersive teaching assisted by SVVR with a flipped classroom model can improve the students' argumentative essay writing skills, class engagement, and perceptions. Improved argumentative essay writing skills are evident in the use of stronger and more scientific arguments and evidence to support ideas or claims in accordance with the chosen theme. Increased class engagement is evident across all aspects of cognitive engagement, behavioral engagement, and emotional engagement.

Furthermore, positive perceptions of the intervention's outcomes are evident across all aspects of the argumentative writing learning experience, the role of emotions in the writing learning process, active encouragement in the writing learning process, and strategies for improving writing learning. Improved argumentative essay writing skills, class engagement, and positive student perceptions are due to the integration of SVVR technology and the flipped classroom model, which encourages students to engage optimally in every stage of the learning process. The interactive features of SVVR facilitate students in interacting directly with the material and content of argumentative essay writing, thereby gaining a comprehensive understanding.

The integration of SVVR in writing learning can improve understanding, make experiences more immersive, and add a rich context, as well as stimulating critical thinking skills and developing evidence-based reasoning, thereby improving the quality of the students' argumentative essay writing. The flipped classroom model in this study also facilitates the students' independent learning and provides an opportunity for them to understand the material more comprehensively before participating in class. Thus, immersive teaching assisted by SVVR with a flipped classroom model is not only able to improve argumentative writing skills but can also increase class engagement (cognitive, behavioral, and emotional) and positive student perceptions.

7. Implications and Recommendations

This study implies that the use of virtual reality technology in the learning process is not only able to improve the understanding of difficult concepts or materials but also able to encourage the active participation of learners and create a positive impression of the learning process. This study has several limitations, including a sample that focuses on one level of tertiary education, writing competency focused on one type of argumentative essay, the duration of the intervention still being limited, the lack of exploration of complexity and lexical density in argumentative essay writing, the use of SVVR and flipped classrooms not having been designed into a specific learning method, and not considered gender in the analysis.

Based on these limitations, the researcher recommends several targets for future studies, namely that the research sample needs to be tested at the secondary school level, the duration of the intervention needs to be increased to obtain more optimal results, and that the exploration of the components of argumentation, complexity, and lexical density needs to be done more comprehensively. In addition, further studies on the use of SVVR and flipped classrooms need to be designed as part of a specific learning method and need to be analyzed based on gender, which may affect the competence of writing argumentative essays. In addition, the researcher also recommends that teachers can use virtual reality technology in learning that contains abstract and difficult concepts or materials.

Conflict of Interest

The authors declare that they have no competing interests.

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9. Author Contributions

The first author contributed to the preparation of the introduction, theoretical study, methodology, and presentation of results. The second author contributed to drafting the discussion, conclusions, references, and revisions. All authors contributed equally to the conception and design of the study. All authors have read and approved the published version of the manuscript.

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