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A Goal-Oriented Reflection Strategy-Based Virtual Reality Approach to Promoting Students' Learning Achievement, Motivation and Reflective Thinking

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Abstract: Scholars have emphasized the importance of situating learners in authentic learning contexts. Nevertheless, it is sometimes challenging to provide learners with real contexts owing to various reasons, such as safety or economic consideration. The advent of virtual reality (VR) has provided the opportunity to enable learners to experience and interact in authentic contexts. On the other hand, researchers have pinpointed that, during the VR learning process, a student's attempt or engagement levels play an important role in their knowledge gains. That is, without a clear goal, their learning outcomes could be disappointing. Hence, the present study proposes a goal-oriented reflection strategy-based VR (GRS-VR) model. Moreover, a VR-based learning system is developed based on the model. To examine the effectiveness of the proposed approach, a quasi-experiment was conducted in an English-speaking course at a junior high school. Two classes of ninth graders were recruited in this study: one class was an experimental group adopting the GRS-VR learning approach, while the other was a control group adopting the conventional VR (C-VR) learning approach. The results indicated that the experimental group had significantly better English oral performance, learning motivation and reflective thinking than the C-VR group.

Keywords: virtual reality; goal setting; reflection; second language learning; English oral performance

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1. Introduction

Engaging learners in authentic contexts has been identified as an important factor affecting their learning outcomes; for example, in language learning, providing learners with contexts for practicing speaking or listening is crucial [1,2]. However, owning to various considerations, such as safety or cost, it could be challenging to provide learners with real contexts for some courses. For instance, for English as a foreign language (EFL) learners, there are usually few opportunities for them to practice English speaking in traditional teaching owing to the lack of an environment to communicate in English [3,4]. Without sufficient practices through situational experience and interaction, students' learning outcomes could be disappointing [5]. Virtual reality (VR), which can simulate real-world learning situations and create highly realistic immersive three-dimensional (3D) environments, could be an answer to this problem [6,7]. Several studies have pinpointed that VR provides sufficient opportunities for practice in language learning. Through VR, students can master learning concepts, thereby fostering greater learning motivation and engagement [3,8].

However, some researchers and teachers have raised questions about VR, indicating that it may make students addicted to operation and playing. Students may not be able to fully understand the required knowledge, thus hindering the learning effects [9,10]. Researchers have also specified that although the use of technology-assisted learning can enhance learners' interest in learning, without appropriate learning strategies, they still may not achieve the expected results [11].

Goal orientation is considered as a potential learning process that can increase students' motivation and achievement, as well as help them adopt effective learning strategies [12]. Moreover, the attainment of learning goals is related to mastery of knowledge, meaning that with the establishment of learning goals, students will have a deeper understanding of the learning topics [13]. Before learning, students are guided to focus on the learning content by planning their own learning goals [14,15]. Moreover, the systematic prompts for reflection can guide them to reflect on their own learning status [16]. Researchers have revealed that when students engage in meaningful reflection, they review the previous events, issues, beliefs, feelings and actions [17]. Through the reflective process, students' metacognitive abilities can be improved [18].

As a result, the present study developed a goal-oriented reflection strategy-based virtual reality (GRS-VR) system and applied it in English classes at a junior high school. An experiment was conducted to answer the following research questions:

1. Can the GRS-VR system improve students' English oral performance in comparison with the conventional Virtual Reality (C-VR) system?
2. Can the GRS-VR system enhance students' learning motivation in comparison with the C-VR system?
3. Can the GRS-VR system increase students' reflective thinking in comparison with the C-VR system?

2. Literature Review

2.1. VR in Education

Experiential learning [19] is one of the learning theories supporting the use of VR for teaching. Many studies have verified the possibility of conducting experiential learning activities with the assistance of VR [1,6]. VR-based learning environments can make learners feel as if they are in real situations; through the visual and sensory stimulation in the interface, learners can be more immersed in learning [20]. In recent years, there have been numerous studies on the application of VR in education. For example, Ref. [21] used virtual reality as a vocational training tool; the results showed that such teaching had a positive effect on learners, and that VR could effectively impart the professional vocational knowledge to learners. Additionally, other studies have employed VR to engage students in the identification of different genres of music; the findings disclosed that use of VR could improve music education in elementary schools, encouraging students to actively listen to the music and focus on learning [22].

Above all, VR is very helpful for education and learning. Researchers have revealed that in language learning, using VR will have greater benefits [23]. In the past, some scholars used VR to teach English speaking, and found that it was helpful for students' English oral performance [1]. Other scholars also utilized VR to teach English vocabulary; the results showed that the interactivity of VR applications and challenges based on game design could enable students to easily enter the flow state and enhance their motivation for language learning [24].

Although the above studies have specified that VR is conducive to language learning, there are still scholars who question VR. For instance, students may pay excessive attention to the virtual environment, resulting in a decrease in learning attention [25] or affecting their learning achievement [10]. Therefore, many researchers have reported that in the learning process, appropriate scaffolding is required to guide student learning [9,11]. Based on the abovementioned reasons, this study adopted goal-oriented reflective learning strategies

as learning scaffolding in VR, so that students could focus on the learning content and improve their English oral skills.

2.2. Goal-Oriented Reflection Learning Strategies

Over the past three decades, researchers have continued to focus on the goal-oriented theory [26]. This theory was developed from the social-cognitive framework to enhance student motivation in learning environments [27]. Achieving goals or learning tasks is related to learners' abilities, which also means that they need to have a deeper understanding of the learning topics [13]. Studies have also pointed out that goal orientation can help students focus on learning, comprehend knowledge and develop skills, which also has positive effects on them [12,28]. Furthermore, it is also crucial for learners to observe and track their own learning performance, as well as to reflect on the goals and learning outcomes [14–16].

Among higher-order thinking skills, the concept of reflective thinking was proposed by Dewey in 1933 [29], who indicated that reflective thinking is active, persistent and careful thinking about any beliefs or hypotheses, and that personal and intellectual growth can be promoted through reflective thinking. Moreover, reflective behaviors are effective for learners' cognition [16]. Ref. [30] stated that critical reflection is not an intuitive skill, and that reflective thinking should be developed in an appropriate educational environment. Several studies have shown that using reflective strategies can effectively help learners learn [31,32]. For instance, Ref. [11] requested that learners reflect on whether their swing movements met the criteria in a badminton course; the results showed that it could not only effectively improve their skill performance, but it also facilitated their self-reflection.

Hence, this study developed a GRS-VR system. Through the situational environment provided by VR and the goal-oriented scaffolding, it assisted students in goal setting in the learning process, and guided them to conduct self-reflection. They carried out self-judgment and casual attribution based on their own learning results, as well as adjusting their learning goals and establishing strategies, thereby enhancing their English-speaking skills and facilitating their higher-order thinking skills.

2.3. Goal-Oriented Reflection Strategy-Based Virtual Reality System

The structure of the goal-oriented reflection strategy-based virtual reality (GRS-VR) system is shown in Figure 1. It consisted of a teacher management model, a learner interface, a goal-oriented reflection guiding system, a VR interactive learning module and a set of databases (i.e., a learning material database, a quiz database, a learning log database and a learner profile database). The goal-oriented reflection guiding system included a goal-setting module and a reflection-guiding module. Through these databases and modules, it assisted students in VR learning activities.

When learners entered the VR system to start learning (see Figure 2), the system firstly asked them to set learning goals, including the target numbers of collected stars (i.e., gained scores), explored scenes and activated tags.

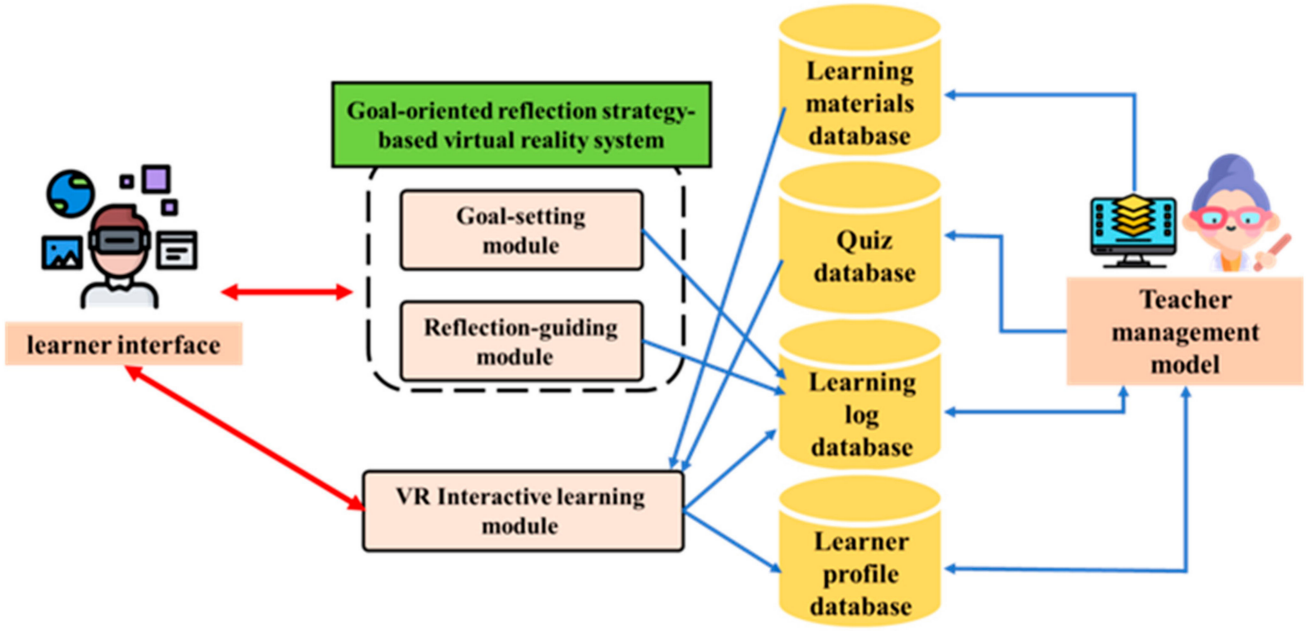

Figure 1. Structure of the GRS-VR system.

Figure 2. Virtual reality interface for goal setting.

In the learning process, the system required learners to interact and have a conversation with the characters (see Figure 3). The characters guided learners to answer relevant questions, and all their English spoken responses were recorded by the system. Whenever learners completed a VR task, they obtained a corresponding score.

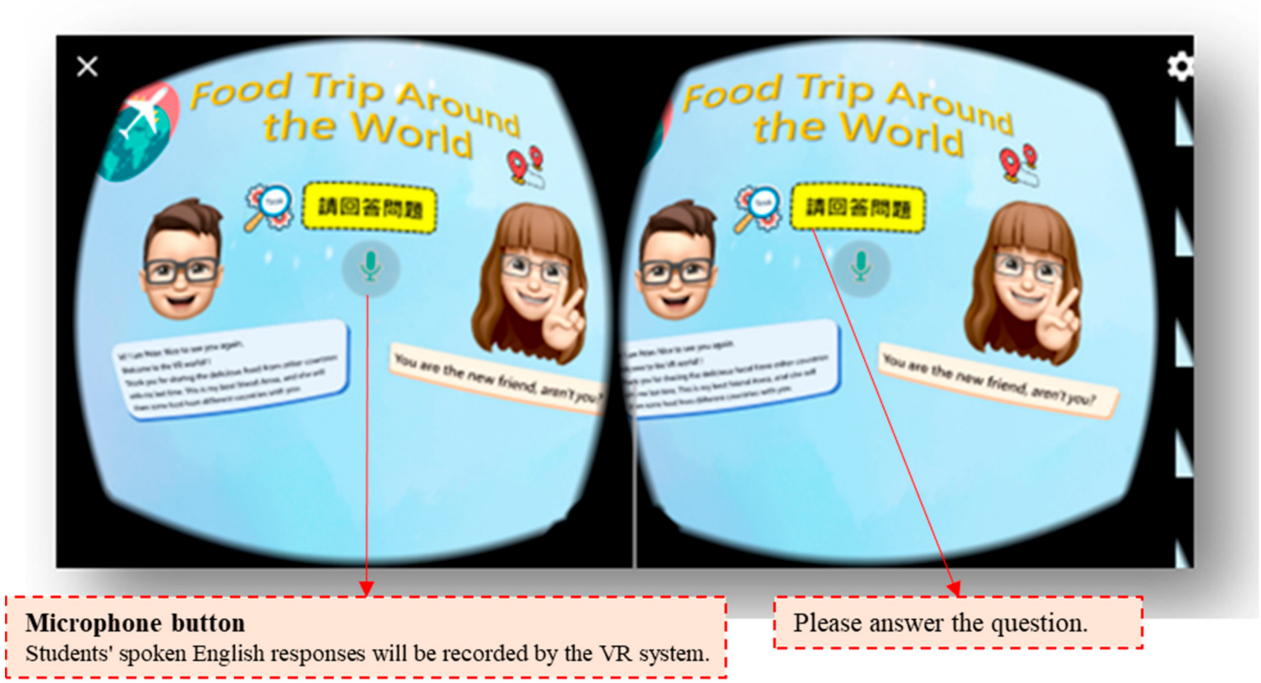

Figure 3. Virtual reality interface for English oral practice.

During the learning process in the VR system, the teaching materials were presented in multiple ways such as videos, pictures and audio. As shown in Figure 4, this level presents 3D scenarios to enable learners to experience and interact with the authentic contexts.

Figure 4. Virtual reality interface for the authentic contexts.

Additionally, learners could check their learning status at any time, as shown in Figure 5. After completing a learning task, learners were guided by the VR system to carry out self-reflection by examining whether they have achieved the goals they planned. Accordingly, they can reschedule their time and set new goals for the next learning stage.

Figure 5. Virtual reality interface for checking learning status.

3. Experimental Design

3.1. Participants

A total of 48 junior high school students in northern Taiwan were recruited in the experiment, with an average age of 14 to 15 years. They were divided into two classes: an experimental class (n = 26) adopting the GRS-VR approach and a control class (n = 22) adopting the C-VR approach. Both classes were taught by the same teacher.

3.2. Instruments

The instruments employed in the present study consisted of the pre- and post-test of English oral performance, the learning motivation questionnaire and the reflective thinking questionnaire.

The pre- and post-test of English oral performance were developed by two teachers with more than 10 years of English teaching experience. The rubrics of English oral performance were adopted from Ref. [1] for speaking English. As shown in Table 1, it contained six dimensions on a scale of 1 to 4, that is, accuracy, comprehensibility and pronunciation, fluency, comprehension, content and maturity of the language. Students' English oral performance was evaluated by two English teachers with more than 10 years of teaching experience. Their inter-rater reliability (kappa value) was 0.80, which was higher than 0.75, implying a very high consistency between the two English teachers' ratings [33].

Table 1. Rubrics of English oral performance.

Dimension	4	3	2	1
Accuracy	Using sentence structure, vocabulary and grammar correctly without errors	Using sentence structure, vocabulary and grammar correctly with few errors	Using sentence structure, vocabulary and grammar correctly with several errors	Using sentence structure, vocabulary and grammar correctly (many errors)
Comprehensibility and pronunciation	Communicating thoughts and being understood. Using correct pronunciation without errors	Communicating thoughts and being understood. Using correct pronunciation with few errors	Communicating thoughts and being understood. Using correct pronunciation with several errors	Not able to communicate thoughts or be understood
Fluency	Communicating clearly and smoothly	Communicating clearly and smoothly with a little hesitation	Being able to communicate with some prompts	Not able to communicate clearly or smoothly
Comprehension	Understanding and always responding appropriately	Understanding most verbal cues and mostly responding appropriately	Understanding some verbal cues and sometimes requiring prompts	Not able to understand verbal cues or to respond
Content	Content with all required information	Content with most required information	Content with some required information	Content with little required information
Maturity of the language	Including details beyond the minimum requirements (word choices/ expressions/gestures)	Including details beyond the minimum requirements	Including minimal or no details beyond the minimum requirements	Not able to utilize the language well

The learning motivation questionnaire was developed by Ref. [34] based on Ref. [35]. It included three items for intrinsic motivation and three for extrinsic motivation, and adopted a 5-point Likert scale. The Cronbach's alpha values of intrinsic and extrinsic motivation were 0.87 and 0.77, respectively.

The reflective thinking questionnaire was adapted from Ref. [36]. It consisted of four items and adopted a 5-point Likert scale. The Cronbach's alpha value was 0.73.

3.3. Experimental Procedure

The experimental procedure is shown in Figure 6. Before the learning activities, in the first week, both groups of learners were required to complete the pre-test of English oral performance and pre-questionnaires, including the learning motivation questionnaire, and the reflective thinking questionnaire. Afterwards, the researchers explained the operation of the VR learning system. The experimental group adopted the GRS-VR system, while the control group adopted the C-VR system. Except for the goal-setting reflective strategy, all the learning content, interaction and learning tasks in the C-VR system were identical to those in the GRS-VR system. After the VR learning activities, the two groups took the post-test of English oral performance and completed the post-questionnaires.

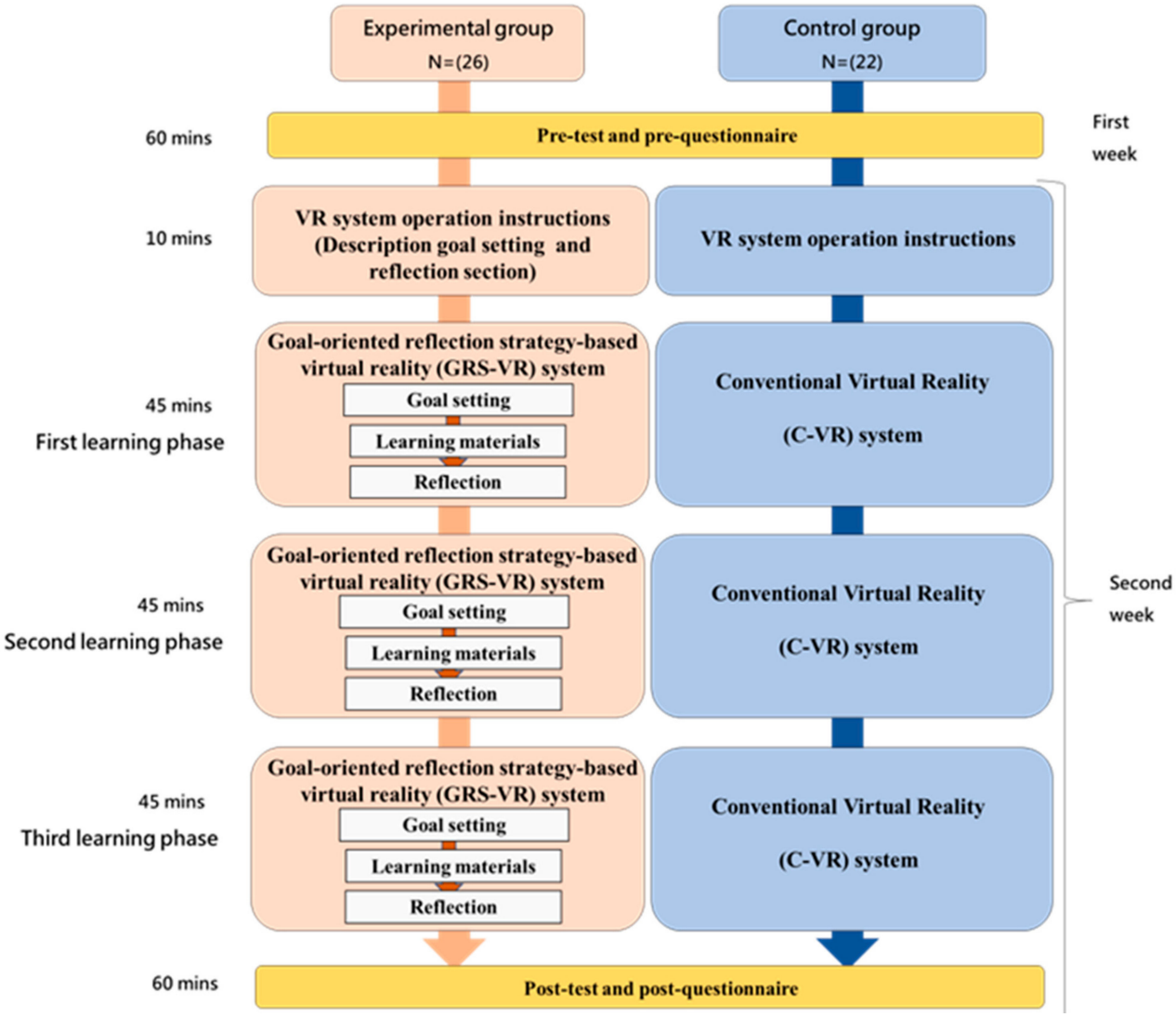

Figure 6. Experimental procedure.

4. Experimental Results

4.1. Analysis of English Oral Performance

The one-way analysis of covariance (ANCOVA) was employed to evaluate learners' English oral performance. The Levene's test on the two groups' test scores was performed first, showing that the assumption of the equality of variances was met ($F = 0.22$, $p = 0.65 > 0.05$). Then, the homogeneity of regression coefficients within groups was employed; the results revealed that the assumption of the homogeneity of variances within groups was satisfied ($F = 1.67$, $p = 0.20 > 0.05$), implying the linear relationship between the covariate and dependent variable within groups. The mean and adjusted mean of the experimental group were 16.42 and 16.06, while those of the control group were 14.00 and 14.44 (see Table 2). Thus, the GRS-VR system could effectively improve learners' English oral performance ($F = 11.32$, $p = 0.002 < 0.01$).

Table 2. The one-way ANCOVA results of the two groups' English oral performance.

Group	*N*	Mean	SD	Adjusted Mean	Adjusted SD	*F*	η^2
Experimental group	26	16.42	3.61	16.06	0.33	11.32 **	0.20
Control group	22	14.00	4.27	14.44	0.35		

** $p < 0.01$.

Then, the six dimensions of English oral performance were analyzed, that is, accuracy, comprehensibility and pronunciation, fluency, comprehension, content and maturity of the language. Firstly, the Levene's test on the two groups' test scores was performed, revealing that the assumption of the equality of variances was satisfactory. Then, the homogeneity of regression coefficients within groups was employed; the results showed that the assumption of the homogeneity of variances within groups was met, indicating the linear relationship between the covariate and dependent variable within groups. The analytic results are illustrated in Table 3, showing that the GRS-VR system could effectively enhance learners' English oral performance in four dimensions, which were comprehensibility and pronunciation ($F = 5.23$, $p = 0.03 < 0.05$), fluency ($F = 6.91$, $p = 0.01 < 0.05$), content ($F = 8.64$, $p = 0.005 < 0.01$) and maturity of the language ($F = 6.31$, $p = 0.02 < 0.05$).

Table 3. The one-way ANCOVA results of the two groups' English oral performance in six dimensions.

Dimension	Group	*N*	Mean	SD	Adjusted Mean	Adjusted SD	*F*	η^2
Accuracy	Experimental group	26	2.96	0.60	2.90	0.10	0.94	-
	Control group	22	2.68	0.72	2.76	0.10		
Comprehensibility and pronunciation	Experimental group	26	2.85	0.61	2.85	0.11	5.23 *	0.10
	Control group	22	2.50	0.74	2.50	0.11		
Fluency	Experimental group	26	2.65	0.75	2.64	0.09	6.91 *	0.13
	Control group	22	2.27	0.77	2.29	0.10		
Comprehension	Experimental group	26	2.62	0.70	2.58	0.90	2.57	-
	Control group	22	2.32	0.80	2.36	0.98		
Content	Experimental group	26	2.77	0.71	2.69	0.09	8.64 **	0.16
	Control group	22	2.18	0.91	2.28	0.10		
Maturity of the language	Experimental group	26	2.58	0.70	2.47	0.08	6.31 *	0.12
	Control group	22	2.05	0.79	2.18	0.08		

* $p < 0.05$, ** $p < 0.01$.

4.2. Learning Motivation

ANCOVA was employed to evaluate learners' learning motivation. The Levene's test on the two groups' scores was performed first, showing that the assumption of the equality of variances was met ($F = 0.41$, $p = 0.53 > 0.05$). Then, the homogeneity of regression coefficients within groups was employed; the results revealed that the assumption of the homogeneity of variances within groups was satisfied ($F = 0.36$, $p = 0.85 > 0.05$), implying the linear relationship between the covariate and dependent variable within groups. The mean and adjusted mean of the experimental group were 16.42 and 16.06, while those of the control group were 14.00 and 14.44 (see Table 2). The ANCOVA results are shown in Table 4, and indicate that students adopting the GRS-VR approach had significantly higher intrinsic motivation ($F = 4.58$, $p = 0.038 < 0.05$) and extrinsic motivation ($F = 6.19$, $p = 0.017 < 0.05$) than those adopting the C-VR approach.

Table 4. The one-way ANCOVA results of the two groups' learning motivation in two dimensions.

Dimension	Group	*N*	Mean	SD	Adjusted Mean	Adjusted SD	*F*	η^2
Intrinsic motivation	Experimental group	26	4.04	0.65	4.02	0.12	4.58 *	0.09
	Control group	22	3.63	0.50	3.66	0.13		
Extrinsic motivation	Experimental group	26	4.08	0.58	4.08	0.12	6.19 *	0.12
	Control group	22	3.65	0.56	3.65	0.12		

* $p < 0.05$.

4.3. Reflective Thinking

ANCOVA was performed to evaluate learners' reflective thinking. Firstly, the Levene's test on the two groups' scores was performed, revealing that the assumption of the equality of variances was satisfactory ($F = 0.001$, $p = 0.98 > 0.05$). Then, the homogeneity of regression coefficients within groups was employed; the results showed that the assumption of the homogeneity of variances within groups was met ($F = 1.89$, $p = 0.180 > 0.05$), indicating the linear relationship between the covariate and dependent variable within groups. The adjusted mean of the experimental group was 3.86, while that of the control group was 3.07. The analytic results are illustrated in Table 5, showing that the GRS-VR system could effectively increase learners' reflective thinking ($F = 10.57$, $p < 0.01$).

Table 5. The one-way ANCOVA results of the two groups' reflective thinking.

Group	*N*	Mean	SD	Adjusted Mean	Adjusted SD	*F*	η^2
Experimental group	26	3.83	0.60	3.86	0.16	10.57 **	0.19
Control group	22	3.11	1.07	3.07	0.17		

** $p < 0.01$.

5. Discussion and Conclusions

The present study aimed to apply the goal-oriented reflection strategy (GRS) in a VR environment, and to explore its effects on learners' English oral performance, learning motivation and reflective thinking. Based on the experimental results and analysis, learners adopting the GRS-VR approach had significantly better English oral performance than those adopting the C-VR approach ($F = 11.32$, $p = 0.002 < 0.01$) which was in line with previous studies. Refs. [37,38] pointed out that requesting students to set goals and reflect on their learning process could help them pay more attention to the learning content.

This study further analyzed the six dimensions of learners' English oral performance, and uncovered that the experimental group significantly outperformed the C-VR group in the four dimensions, that is, comprehensibility and pronunciation ($F = 5.23$, $p = 0.03 < 0.05$), fluency ($F = 6.91$, $p = 0.01 < 0.05$), content ($F = 8.64$, $p = 0.005 < 0.01$) and maturity of the language ($F = 6.31$, $p = 0.02 < 0.05$). In terms of comprehensibility and pronunciation and fluency, it was inferred that after the experimental group set the learning goals, they made efforts to express their ideas, as well as paid attention to the accuracy of the pronunciation and fluency so as to achieve the goals. With regard to the content and maturity of the language, even though both groups used identical learning materials, the experimental group's English oral performance contained richer content and multiple types of information. Hence, it was inferred that the scaffolding from the goal-oriented reflective learning strategy could facilitate learners' active discovery of their deficiencies during the reflective process, and then they would work harder to make it up. In addition, when learners were actively willing to convey their ideas, they tried their best to use different vocabulary, thereby improving their mastery of English.

Regarding learning motivation, based on the experimental results and analysis, the experimental group significantly outperformed the control group in learning motivation

($F = 7.94$, $p = 0.007 < 0.01$). It was inferred that after the VR system guided learners to set goals, they engaged in learning as much as possible in the VR environment to achieve the established goals. This learning behavior was in accordance with the goal setting theory proposed by Ref. [39]. It further explained that goal setting combining the goal-oriented reflective learning strategy would affect learners' learning behaviors in the VR process and foster their learning behaviors and motivation.

In terms of reflective thinking, the experimental group adopting the GRS-VR approach had significantly higher learning motivation than the control group adopting the C-VR approach. This was consistent with previous research, which found that in language learning, guiding learners to set learning goals and check their current individual learning situation was beneficial to their reflective thinking skills [37]. Past studies have also denoted that systematic and critical examination of one's own learning situation can improve students' learning outcomes [11,40]. The findings of this study suggest that since the GRS-VR system guides learners to carry out self-reflection and re-plan the next learning strategy, it could enhance their reflection skills.

Despite the positive findings, the current study still has some limitations that should be noted. First of all, due to the short experimental time, the experimental results cannot be generalized to long-term effects on the learners. In addition, this study only explored the learning effects of junior high school students in English speaking courses; thus, the results may not be generalized to other age groups and other aspects (e.g., writing) in English courses.

To sum up, this study verified the effects of VR on English oral performance. The results revealed that the currently proposed GRS-VR approach could effectively enhance learners' English-speaking skills, learning motivation and reflective thinking. Based on the results, this study puts forward three suggestions for future related research: (1) It is suggested that a longer experiment can be carried out to understand the effects of this approach on students' learning performance; (2) This approach can be adopted in English courses for different age groups to examine whether it has similar benefits for students at different ages; and (3) The approach proposed in this study can be adopted for other English learning goals (e.g., reading comprehension, listening and writing) to further explore the scope of its application.

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Institutional Review Board Statement: The study was approved by the Research Ethics Committee of Graduate Institute of Digital Learning and Education with approval number REA-2021-1205A. The participants were protected by hiding their personal information during the research process. They knew that the participation was voluntary and they could withdraw from the study at any time.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data supporting reported results in the current study can be obtained from the corresponding author by e-mail.

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Conflicts of Interest: The authors declare no conflict of interest.

References

1. Chien, S.Y.; Hwang, G.J.; Jong, M.S.Y. Effects of peer assessment within the context of spherical video-based virtual reality on EFL students' English-Speaking performance and learning perceptions. *Comput. Educ.* **2020**, *146*, 103751. [CrossRef]
2. Zhang, S. The Role of Input, Interaction and Output in the Development of Oral Fluency. *Engl. Lang. Teach.* **2009**, *2*, 91–100. [CrossRef]
3. Chen, C.H.; Hung, H.T.; Yeh, H.C. Virtual reality in problem-based learning contexts: Effects on the problem-solving performance, vocabulary acquisition and motivation of English language learners. *J. Comput. Assist. Learn.* **2021**, *37*, 851–860. [CrossRef]
4. Terhune, N.M. Language learning going global: Linking teachers and learners via commercial Skype-based CMC. *Comput. Assist. Lang. Learn.* **2016**, *29*, 1071–1089. [CrossRef]
5. Ebadi, S.; Ebadijalal, M. The effect of Google Expeditions virtual reality on EFL learners' willingness to communicate and oral proficiency. *Comput. Assist. Lang. Learn.* **2022**, *35*, 1975–2000. [CrossRef]
6. Lorenzo, G.; Lledó, A.; Arráez-Vera, G.; Lorenzo-Lledó, A. The application of immersive virtual reality for students with ASD: A review between 1990–2017. *Educ. Inf. Technol.* **2019**, *24*, 127–151. [CrossRef]
7. Papanastasiou, G.; Drigas, A.; Skianis, C.; Lytras, M.; Papanastasiou, E. Virtual and augmented reality effects on K-12, higher and tertiary education students' twenty-first century skills. *Virtual Real.* **2019**, *23*, 425–436. [CrossRef]
8. Alizadeh, M. Virtual reality in the language classroom: Theory and practice. *Call-Ej* **2019**, *20*, 21–30.
9. Chang, S.C.; Hsu, T.C.; Chen, Y.N.; Jong, M.S.Y. The effects of spherical video-based virtual reality implementation on students' natural science learning effectiveness. *Interact. Learn. Environ.* **2020**, *28*, 915–929. [CrossRef]
10. Geng, J.; Jong, M.S.Y.; Luk, E.; Jiang, Y. Comparative study on the pedagogical use of interactive spherical video-based virtual reality: The EduVenture-VR experience. In *2018 International Symposium on Educational Technology (ISET)*; IEEE: Piscataway, NJ, USA, 2018; pp. 261–263. [CrossRef]
11. Lin, Y.N.; Hsia, L.H.; Hwang, G.J. Fostering motor skills in physical education: A mobile technology-supported ICRA flipped learning model. *Comput. Educ.* **2022**, *177*, 104380. [CrossRef]
12. Lin, G.Y. Scripts and mastery goal orientation in face-to-face versus computer-mediated collaborative learning: Influence on performance, affective and motivational outcomes, and social ability. *Comput. Educ.* **2020**, *143*, 103691. [CrossRef]
13. Mädamürk, K.; Tuominen, H.; Hietajärvi, L.; Salmela-Aro, K. Adolescent students' digital engagement and achievement goal orientation profiles. *Comput. Educ.* **2021**, *161*, 104058. [CrossRef]
14. Zimmerman, B.J. Becoming a self-regulated learner: An overview. *Theory Into Pract.* **2002**, *41*, 64–70. [CrossRef]
15. Zimmerman, B.J. Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *Am. Educ. Res. J.* **2008**, *45*, 166–183. [CrossRef]
16. Orakcı, Ş. Exploring the relationships between cognitive flexibility, learner autonomy, and reflective thinking. *Think. Ski. Creat.* **2021**, *41*, 100838. [CrossRef]
17. Liu, M.; Kitto, K.; Shum, S.B. Combining factor analysis with writing analytics for the formative assessment of written reflection. *Comput. Hum. Behav.* **2021**, *120*, 106733. [CrossRef]
18. Gibson, A.; Kitto, K.; Bruza, P. Towards the discovery of learner metacognition from reflective writing. *J. Learn. Anal.* **2016**, *3*, 22–36. [CrossRef]
19. Kolb, D.A. *Experiential Learning: Experience as the Source of Learning and Development*; FT Press: Upper Saddle River, NJ, USA, 2014. Available online: https://www.academia.edu/download/31202086/Kolb.pdf (accessed on 12 January 2023).
20. Liu, D.; Bhagat, K.K.; Gao, Y.; Chang, T.W.; Huang, R. The potentials and trends of virtual reality in education. In *Virtual, Augmented, and Mixed Realities in Education*; Springer: Singapore, 2017; pp. 105–130. [CrossRef]
21. Pedram, S.; Palmisano, S.; Skarbez, R.; Perez, P.; Farrelly, M. Investigating the process of mine rescuers' safety training with immersive virtual reality: A structural equation modelling approach. *Comput. Educ.* **2020**, *153*, 103891. [CrossRef]
22. Degli Innocenti, E.; Geronazzo, M.; Vescovi, D.; Nordahl, R.; Serafin, S.; Ludovico, L.A.; Avanzini, F. Mobile virtual reality for musical genre learning in primary education. *Comput. Educ.* **2019**, *139*, 102–117. [CrossRef]
23. Alfadil, M. Effectiveness of virtual reality game in foreign language vocabulary acquisition. *Comput. Educ.* **2020**, *153*, 103893. [CrossRef]
24. Chen, Y.L.; Hsu, C.C. Self-regulated mobile game-based English learning in a virtual reality environment. *Comput. Educ.* **2020**, *154*, 103910. [CrossRef]
25. Lin, H.C.S.; Yu, S.J.; Sun, J.C.Y.; Jong, M.S.Y. Engaging university students in a library guide through wearable spherical video-based virtual reality: Effects on situational interest and cognitive load. *Interact. Learn. Environ.* **2021**, *29*, 1272–1287. [CrossRef]
26. Wigfield, A.; Cambria, J. Students' achievement values, goal orientations, and interest: Definitions, development, and relations to achievement outcomes. *Dev. Rev.* **2010**, *30*, 1–35. [CrossRef]
27. Midgley, C.; Kaplan, A.; Middleton, M.; Maehr, M.L.; Urdan, T.; Anderman, L.H.; Roeser, R. The development and validation of scales assessing students' achievement goal orientations. *Contemp. Educ. Psychol.* **1998**, *23*, 113–131. [CrossRef]
28. Kaplan, A.; Maehr, M.L. The contributions and prospects of goal orientation theory. *Educ. Psychol. Rev.* **2007**, *19*, 141–184. [CrossRef]

29. Dewey, J. *How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process*; D.C. Heath: Boston, MA, USA, 1933.
30. Ryan, M. The pedagogical balancing act: Teaching reflection in higher education. *Teach. High. Educ.* **2013**, *18*, 144–155. [CrossRef]
31. Hsu, F.H.; Lin, I.H.; Yeh, H.C.; Chen, N.S. Effect of Socratic Reflection Prompts via video-based learning system on elementary school students' critical thinking skills. *Comput. Educ.* **2022**, *183*, 104497. [CrossRef]
32. Yilmaz, F.G.K.; Keser, H. The impact of reflective thinking activities in e-learning: A critical review of the empirical research. *Comput. Educ.* **2016**, *95*, 163–173. [CrossRef]
33. Bakeman, R.; Gottman, J.M. *Observing Interaction: An Introduction to Sequential Analysis*; Cambridge University Press: Cambridge, UK, 1997.
34. Wang, L.C.; Chen, M.P. The effects of game strategy and preference-matching on flow experience and programming performance in game-based learning. *Innov. Educ. Teach. Int.* **2010**, *47*, 39–52. [CrossRef]
35. Pintrich, P.R.; Smith, D.A.F.; Garcia, T.; McKeachie, W.J. *A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ)*; ERIC Document Reproduction Service No. ED 338122; National Center for Research to Improve Postsecondary Teaching and Learning: MI, USA, 1991.
36. Kember, D.; Leung, D.Y.; Jones, A.; Loke, A.Y.; McKay, J.; Sinclair, K.; Yeung, E. Development of a questionnaire to measure the level of reflective thinking. *Assess. Eval. High. Educ.* **2000**, *25*, 381–395. [CrossRef]
37. Li, H.; Majumdar, R.; Chen, M.R.A.; Ogata, H. Goal-oriented active learning (GOAL) system to promote reading engagement, self-directed learning behavior, and motivation in extensive reading. *Comput. Educ.* **2021**, *171*, 104239. [CrossRef]
38. Lai, C.L.; Hwang, G.J. A self-regulated flipped classroom approach to improving students' learning performance in a mathematics course. *Comput. Educ.* **2016**, *100*, 126–140. [CrossRef]
39. Locke, E.A.; Latham, G.P. Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *Am. Psychol.* **2002**, *57*, 705. [CrossRef]
40. Richter, E.; Hußner, I.; Huang, Y.; Richter, D.; Lazarides, R. Video-based reflection in teacher education: Comparing virtual reality and real classroom videos. *Comput. Educ.* **2022**, *190*, 104601. [CrossRef]