future internet

MDPI

Article

Collaboration in a Virtual Reality Serious Escape Room in the Metaverse Improves Academic Performance and Learners' Experiences

Antonia-Maria Pazakou [1], Stylianos Mystakidis [1,2,*] and Ioannis Kazanidis [1]

[1] Department of Computer Science, Democritus University of Thrace, 65404 Kavala, Greece; anpazak@cs.ihu.gr (A.-M.P.); kazanidis@cs.duth.gr (I.K.)
[2] School of Natural Sciences, University of Patras, 26504 Rion, Greece
* Correspondence: smyst@upatras.gr

Abstract: The evolving potential of virtual reality and the Metaverse to create immersive, engaging learning experiences and of digital escape room games to provide opportunities for active, autonomous, personalised learning has brought both to the forefront for educators seeking to transform traditional educational settings. This study investigated the impact of collaboration within a virtual reality serious escape room game in the Metaverse that was designed for English as a Foreign Language (EFL) learners to explore how this approach influences their academic performance and overall learning experience. A comparative research approach was adopted using twenty (n = 20) adult learners divided into two equal-sized groups; the experimental group completed the virtual reality escape room in pairs, while the control group completed it individually. Mixed methods were employed, utilising a pre- and post-test to measure academic performance, as well as a questionnaire and two focus groups to evaluate participants' learning experiences. Results indicated a trend of learners working collaboratively showing better learning outcomes and experience, offering valuable insights regarding the integration of serious Metaverse games in language-focused educational contexts.

Keywords: virtual reality; metaverse; escape rooms; serious games; English as a foreign language (EFL); vocabulary learning; collaboration; adult learners; online learning; distance education

Academic Editor: Gianluigi Ferrari

Received: 18 November 2024
Revised: 20 December 2024
Accepted: 23 December 2024
Published: 6 January 2025

Citation: Pazakou, A.-M.; Mystakidis, S.; Kazanidis, I. Collaboration in a Virtual Reality Serious Escape Room in the Metaverse Improves Academic Performance and Learners' Experiences. *Future Internet* **2025**, *17*, 21. https://doi.org/10.3390/fi17010021

1. Introduction

For decades, traditional education has adhered to a teacher-centred framework characterised by conventional classrooms, treating learners as passive recipients and focusing on standardised testing. However, as learners' needs continuously evolve, educators are reassessing teaching practices to boost their motivation, engagement and participation while ensuring that the intended learning goals are achieved. This shift has led to the emergence of advanced interactive tools and innovative teaching approaches in the educational processes, such as the incorporation of technological and game-like elements, to create more dynamic and inclusive learning environments.

For instance, immersive technologies like virtual reality (VR) and augmented reality (AR) have gained considerable attention by educators for offering highly interactive, engaging environments that deepen understanding and improve academic achievement by motivating learners to actively participate in the learning process [1–3]. Especially, learning approaches based on VR can have a number of positive effects, including fostering learners' engagement and motivation and broadening learning opportunities beyond

face-to-face instruction [4]. VR can also improve learning quality, having a significantly positive impact on students' learning outcomes [5–7], and potentially foster collaborative learning experiences by enabling shared simulated spaces that support remote collaboration, enhance communication and facilitate the co-construction of knowledge among learners [8]. VR typically refers to a computer-generated environment that replicates the real world, providing a sense of immersion by creating the illusion of physical presence [9]. Based on the user's level of immersion, three different types of VR can be identified: fully immersive, semi-immersive and non-immersive [10]. In educational settings, the choice largely depends on the needs, competencies and availability of resources within the given educational context. For instance, in non-immersive VR, users interact with the virtual environment via a computer, controlling a character's actions through input devices like a keyboard or mouse [10]. The social 3D virtual environment in which users' avatars interact and collaborate is the so-called Metaverse [11]. The Metaverse is an evolving network of interoperable virtual worlds and multiuser social VR and AR spaces that is mature for flexible, online, distance, embodied communication and cooperation [12].

The incorporation of game-like approaches in the educational process is also becoming more and more popular. Escape room (ER) games, in particular, have sparked the interest of educators who aim to create active and engaging learning environments. Escape rooms have been defined as "live-action team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited amount of time" [13] (p. 1). When games are designed with objectives other than pure entertainment, they are characterised as serious; thus, in education, serious escape room games are those that combine learning with gameplay [14]. In this context, they also have the potential to foster meaningful communication and collaboration [15]. Nonetheless, in the educational context, there are also cases of learners playing ERs individually [16]. Higher education is the most prominent level of escape room application, while ERs seem to be particularly popular in the medical field, followed by STEM and, in general, natural sciences [16–19]. A lot of the available literature focuses on their positive effects on learners' motivation and engagement, as well as on improved learning outcomes; however, the wide majority relies on students' perceptions of learning gains rather than actual test data [16,17,19].

Although both virtual reality and escape rooms are established as effective teaching and learning tools in various educational fields, there is still a lack of evidence in more theoretical fields. More specifically, foreign language learning has been one of the most under-researched fields, both in the application of VR solutions [20,21] and in the integration of ERs [18]. However, the significance of foreign language learning, and particularly English as a Foreign Language (EFL) learning, is undeniable in today's interconnected world. EFL refers to "English language programs in non-English-speaking countries where English is not used as the lingua franca" [22] (p. 85). EFL teaching and learning can be quite complex and challenging, as EFL learners usually practise the language in a more controlled, non-authentic environment, necessitating the creation of simulated real-life scenarios in the classroom.

Combining virtual reality and escape rooms in education, particularly in EFL contexts, can potentially create highly immersive and engaging learning environments, adding a layer of interactivity that traditional educational methods often lack. However, research on the pedagogical value and optimal use of virtual reality escape rooms (VRERs) remains limited, underscoring the need to explore how these approaches can enhance both the emotional and educational outcomes of EFL learners.

1.1. VR Escape Rooms in Education and in EFL Contexts

Despite VR educational escape rooms being a relatively new field, a review concluded that VR is among the variety of tools used in serious educational ER contexts, emphasising its ability to enhance social interaction and collaboration and to make learning more effective [23]. The increasing application of VRERs is evident in a wide range of disciplines, including computer science [24–28], biology [29,30], chemistry [31], environmental engineering [32], history, arts and informatics [33] and even building energy simulation [34], as well as in the context of testing learners' problem-solving, critical thinking and observation skills [35]. With regard to academic performance and learning outcomes, learners, as well as educators, seem to consider VR escape rooms useful for learning [25,31], with several studies concluding that learners' perceptions of their learning, understanding and overall performance improved [27,28,30,32]. Learners' actual academic performance also seems to be positively affected, with a number of studies reporting on improved learning outcomes [26,29,30,32]. In terms of participants' overall user experience, educational VRERs can increase learners' motivation [27–30,32,33] engagement [24,31,34], enjoyment [24,25,27–30,32,34], interest [27,28], satisfaction [29,32] and immersion [26,34]. Learners can become more invested in the learning process due to the entertainment factor of such environments [31], which also helps maintain their attention to the task at hand and increase their curiosity [34].

In EFL, research is still relatively scarce. A few examples can be found on digital escape rooms in purely EFL contexts utilising either desktop-based digital platforms [36–39] or augmented reality [40]. Different areas of focus are observed, including vocabulary [36,40], grammar [39], integrating language learning with history [38], introducing young adult literature [37] and enhancing receptive and productive skills [40]. Apart from a paper that only outlines assessment methods without implementing them [36], the rest focus on practical applications. Results indicate that both students' [37,38] and teachers' [37,40] perceptions of the effectiveness of such environments for learning are quite positive. Nonetheless, only one study talks about students' actual learning outcomes, observing significant improvement in scores from pre- to post-test [39]. Additionally, learners report higher levels of motivation and engagement in this setting [37–39], with teachers also viewing these experiences as capable of positively influencing such affective factors [37,40].

In virtual reality EFL contexts, one example described the development of a 360-degree interactive virtual tour of a university in Mexico during the COVID-19 pandemic, which was later transformed into an escape room to support English language learners [41]. The primary goal was to improve learners' English proficiency. However, the study lacks empirical data on the actual impact of this environment on language-learning outcomes, as no formal testing or assessment was conducted.

A more thoroughly evaluated example of a VRER in English language education is SpEakWise VR [42]. This international telecollaborative seminar combined tandem language learning with gamification elements and social VR in an immersive environment. Tandem language learning is "language-based communication between language learners who are native speakers of different languages, acquiring each other's language as L2" [43] (p. 178). In this case, English and German were the target languages, and participants were tasked with solving multilingual collaborative puzzles structured in a way that resembled an escape room. The study found that the VRER had a positive impact on learners' motivation and engagement, with participants perceiving this dynamic, social virtual environment as a medium that can enhance their language-learning experience.

1.2. Player Dynamics in Educational VRERs: Collaboration and Individual Play

The average size of teams in escape room games is 4.58 people [13]. When it comes to ERs and digital ERs in the educational context, the typical setup includes three to six players [19,23], with five being the most common number [16]. However, there are also instances, though less frequent, of learners working in pairs or participating in single-player escape rooms [16,19,23]. Overall, smaller groups seem to be more effective, as it was observed that teams consisting of more than six participants required more time to play the game and did not actually manage to finish on time [19,23], concluding that the ideal team size of an ER is up to four or five participants [23].

Virtual reality and Metaverse platforms also have the potential to be used both individually and collaboratively in education. In the context of collaborative learning, VR can be an effective way of engaging and motivating learners, as well as supporting remote learning and collaboration [8]. When it comes to VRERs, these are usually designed for single-player experiences [44]. There are, however, examples of multiplayer VR escape rooms. For instance, Ioannou et al. [44] developed a fully immersive VR escape room to explore alternative ways of communication within this environment, indicating that players' engagement and satisfaction increased. Another research study talked about the impact of VR on social processes, examining how it can influence the way people collaborate within an immersive educational virtual reality environment [45]. Results showed that VR can have both a positive and a negative impact on how players communicate and collaborate with each other and that this depends on their level of experience.

The decision regarding whether learners will work independently or in groups, and the size of those groups if working collaboratively, largely depends on pedagogical and technical factors. From a pedagogical point of view, pairs or small groups might be preferred as a way of better simulating personal social interactions [8] or to ensure that all learners are active, involved and immersed in the experience and there are no communication or organisation problems hindering collaboration [19,23]. Conversely, individual experiences can offer an opportunity for more personalised or even self-paced learning. Classroom size, time, facilities [16] and equipment availability [8] can also have a significant impact on player dynamics in a classroom setting.

1.3. Contribution of the Study

Taking all of the above into consideration, it is clear that there are very few studies relating to the implementation of VR or even digital escape rooms in the EFL context, with the majority relying either on students' and teachers' perceptions to report on their effects, or not having undergone empirical testing. Additionally, while both collaborative and non-collaborative VRERs can promote engagement and learning in the educational context, there are no studies that compare the benefits of one approach over the other. In fact, given that the majority of VR escape rooms are usually designed for individual players [44] and taking into account the positive effects of collaboration in education [46], it is interesting to examine whether it can also affect outcomes in a VRER environment.

Therefore, this study aims to investigate the role of collaboration within a VR escape room environment in the Metaverse that was specifically designed for adult EFL learners. The focus was placed on vocabulary, as VR environments can positively affect vocabulary learning and retention in the EFL context [47], while escape rooms in EFL settings foster contextualised learning [48]. The intervention was implemented in a non-formal educational context. Non-formal education refers to any planned educational activity that is not part of a formal educational setting and aims to improve users' skills by addressing their needs [49]. Moreover, it was tested online since immersive technologies are commonly used in distance foreign language- education and can enhance learning achievement, attention,

motivation, engagement and satisfaction, as well as support experiential and collaborative learning [3].

The goal of the current paper is to examine possible effects on learners' academic performance and learning experience when manipulating a variable, i.e., collaboration. In this regard, the following research questions (RQs) were formed:

RQ1: What is the effect of the incorporation of collaboration in a Metaverse VR escape room on EFL learners' academic performance compared to when they play individually?

RQ2: How does collaboration in a Metaverse VRER influence EFL learners' perceived learning effectiveness?

RQ3: What is the role of collaboration in a Metaverse VRER on EFL learners' perceived cognitive benefits?

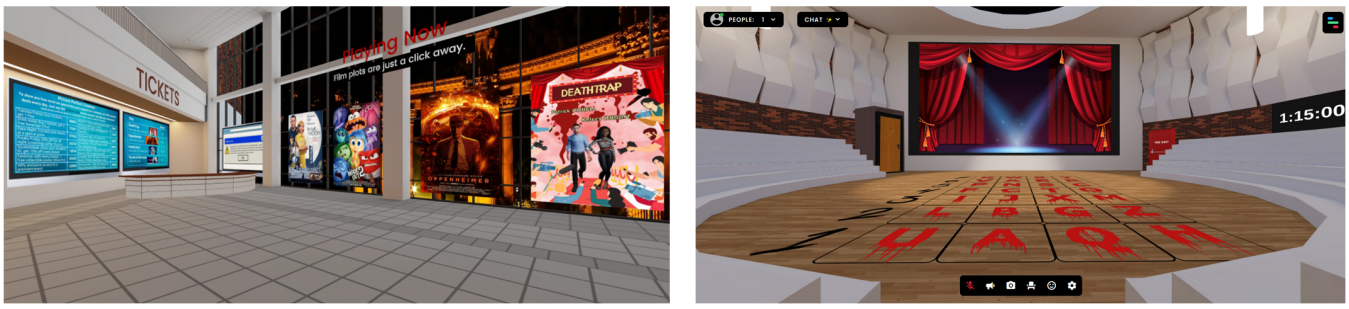
RQ4: To what extent does a collaborative VRER in the Metaverse affect EFL learners' active engagement and control over the learning process?

RQ5: What is the effect of collaboration in a Metaverse VRER on EFL learners' motivation and satisfaction compared to when they play individually?

2. Materials and Methods

2.1. Materials

To answer the research questions, a desktop-based VR educational escape room was designed, following the stages of the Room2Educ8 framework [50]. The game was developed in Frame VR, a user-friendly, no-code Metaverse platform. It had a mystery theme, and learners had to find and save a kidnapped film star within 75′, with the teacher playing the role of the kidnapper/game master. The escape room was divided into two main Frames in order to be able to accommodate a larger number of elements without performance problems being caused. Before entering the ER, a briefing session was conducted virtually in a separate Frame. Another Frame was also added after the final room, leading to the outside, where the debriefing took place. Snapshots of the environment are presented in Figure 1.



(**a**) (**b**)

Figure 1. Snapshots of the VR escape room game. (**a**) The lobby and ticket counters. (**b**) The final room.

From a pedagogical perspective, the VRER was targeted towards adult EFL learners of a B1+ to B2 level according to CEFR. The primary goal was to foster vocabulary acquisition, as vocabulary is foundational in language learning, directly impacting learners' ability to comprehend and produce the target language. More specifically, after consulting with some of the participants, film-related vocabulary was selected, with the ER being proposed as a standalone activity at the beginning of a unit on "Entertainment and the Arts" after learners have been exposed to the topic to help introduce and practise the relevant thematic vocabulary. To complete the ER, they also needed to have some basic comprehension and communication skills in the target language that correspond to their level.

The intervention was based on the 5Es model [51], which is widely adopted by EFL teachers for its potential to promote learner-centred environments and facilitate the educational process [52]. The 5Es represent the five different stages of the learning process, namely Engage, Explore, Explain, Elaborate and Evaluate. In the 'Engage' stage, learners are welcomed to the ER via a video by the game master, and a matching activity helps elicit and build on prior knowledge of film-related vocabulary. In the next two activities, they 'Explore' new vocabulary concepts based on contextual clues. Following that, they 'Explain' their understanding of the new vocabulary by putting into practice the newly acquired knowledge to solve an activity that uses the words in real context. Next, they further 'Elaborate' on that by using the new vocabulary themselves to talk with the game master and get an important clue. Finally, an interactive quiz allows learners to 'Evaluate' their own learning while providing teachers with an opportunity to assess learners' progress. Learners also had the chance to practise reading, listening, speaking, critical thinking, and problem-solving skills by engaging in the various activities. Critical thinking and problem-solving are two of the core 21st-century skills that can be developed in VR environments [53]. In the escape room context, where learners are tasked with synthesising information to solve puzzles and riddles, the development of these skills is facilitated [54].

2.2. Methods

Participants were recruited based on their expressed interest in the study. A prerequisite was that they had to be 18 years or older. Since the sample was not homogenous, in the sense that they were not all part of the same class or with the same background, it was essential to define their level using a language assessment test. To do that, the Cambridge General English Language Assessment Test [55] was chosen after taking into account specific criteria regarding accessibility, conciseness and quality. Twelve participants completed the test prior to the creation of the ER, achieving scores placing them at a B1 to B2 level. These scores determined the level for which the educational intervention was designed, with the rest of the learners being required to achieve scores within this range. Out of 26 individuals who initially expressed interest, 20 met the required proficiency level and were finally selected.

The study incorporated comparative explanatory research [56] to explore and explain how two different learning approaches—collaborative and non-collaborative—impact variables like academic performance and learning experience within a distance VRER environment. The purpose of the study is to examine the differences between the two conditions and answer the question of whether working collaboratively in a VRER has more, less or equal impact on learning outcomes and experience compared to working in the same escape room individually. The 20 participants were randomly assigned to two equal-sized groups: individual players (control group) or players in pairs (experimental group), ensuring that individuals paired together were already acquainted, as is the case in typical classroom settings. The small number of participants dictated the decision to have pairs instead of larger groups in the experimental condition. Synchronous remote collaboration is the most common form of interaction in multiplayer VR games [57]. In this study, participants in pairs worked either remotely or by sharing the same space and device.

A mixed-method research design was used, integrating both quantitative and qualitative data, to increase the accuracy and quality of the research findings [58]. Quantitative data included a pre- and post-test and a questionnaire, while qualitative data were gathered through focus groups. More specifically, data on learners' academic performance before the intervention were collected using a pre-test consisting of 14 multiple-choice questions. The content was determined after consulting a variety of EFL textbooks of the relevant levels. It was also evaluated and validated by three in-service EFL teachers with extensive teaching

experience and diverse expertise across various educational fields, including specialisation in adult education. The final items were approved by all three of them, with comments indicating that the content is well-suited for testing learners' vocabulary knowledge. The same set of questions, but in different order, was also used as a post-test to facilitate the comparison of learners' performance (Appendix A, Table A1).

To evaluate the overall learning experience, particularly the aspects related to learners' perceived learning effectiveness and cognitive benefits, motivation, satisfaction, engagement and control over the learning process, learners completed a 24-item questionnaire adapted from [59]. The particular questionnaire constitutes an adaptation from previous validated instruments and was used in this study to test how desktop virtual reality can influence learning outcomes [59]. The questionnaire was adapted by removing some parts which were not relevant to the current study's aims. Participants provided their responses on a five-point Likert scale, as follows: 1: 'Strongly disagree', 2: 'Disagree', 3: 'Neutral', 4: 'Agree', 5: 'Strongly Agree'. Before the questionnaire items, learners were also asked to fill out some demographic data (Appendix A, Table A2).

In addition to the questionnaire, learners also participated in online focus groups in order to have a chance to further elaborate on the learning experience. They were split into two focus groups of 10 based on whether they had completed the ER alone or in a pair so as to facilitate conversation among participants with similar experiences. The questions that guided the discussion among the focus groups were developed based on the principles outlined by Krueger [60] (Appendix A, Table A3), who is recognised for his work in focus group interviewing. They aimed to promote conversation in order to create a social experience and allow participants to feel more comfortable in sharing their thoughts.

Quantitative data were analysed using descriptive statistics in SPSS. Non-parametric tests were utilised due to the small sample size, the use of ordinal Likert scale data from questionnaires and the potential for non-normal distribution in order to provide a more reliable approach by not assuming data normality. More specifically, the Wilcoxon signed-rank test was used to determine the improvement in pre- and post-test scores within each group, and the Mann–Whitney U-test was used to compare pre- and post-test results between the two groups, as well as to compare questionnaire responses on learning experience across groups. The data from the focus groups were transcribed and organised based on the key themes of the research. The qualitative findings were reviewed alongside the quantitative data to provide a clearer understanding of how participants in the collaborative and individual conditions perceived the learning experience.

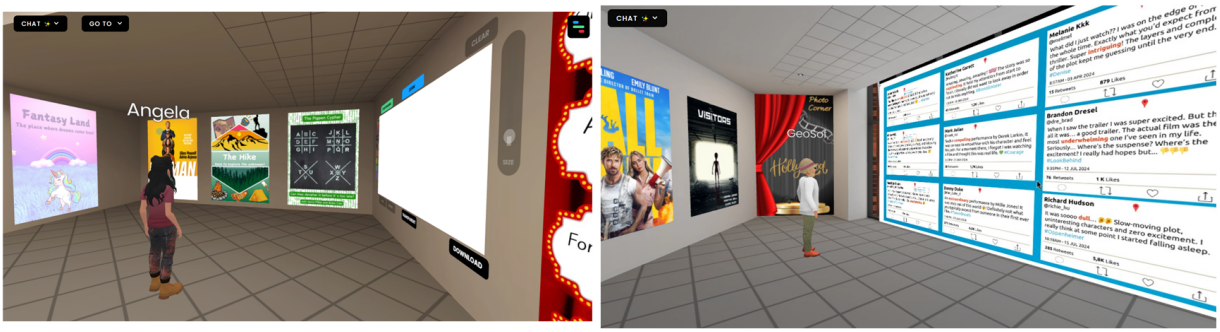
Informed consent was obtained from all participants prior to their voluntary involvement in the study. They were orally informed about the study as well as of their right to withdraw at any point. More specifically, they were told that they would be participating online in a VR escape room activity in English that is part of a research project; thus, they would need to complete some tests and a questionnaire as well as participate in a focus group. All the information was presented in Greek, the participants' native language, to ensure that everyone understood what their participation would entail. Regarding confidentiality, data collected from participants, including pre- and post-test results and questionnaire responses, were anonymised by having them use unique 4-digit identification codes in place of names and using the first, middle or last two digits to report on the results.

Implementation

The implementation and evaluation of the escape room game took place in August 2024. Participants were asked to complete the online language level assessment test within a specific time limit, sending back their results with screenshots. Approximately 15 min before the ER sessions, they were sent the pre-test. A total of 15 live sessions were organised,

namely 10 for each one of the individual participants in the control group and 5 for each one of the pairs in the experimental group. Immediately after participants completed the pre-test, they were sent a link to the first Frame. The communication was thereafter conducted through Frame VR. The briefing session with the instructions and the storyline video took place in this Frame, lasting approximately 15 to 20 min, depending on whether learners chose to customise their avatar as well as on their level of familiarity with technology. At the end of it, learners were directed to the ER through a link in the first Frame.

All participants managed to escape within the appointed time frame of one hour and 15 min, with an average completion time of 71 min and 14 s. The teacher was present in the escape room in two modes, namely as a spectator and as an avatar, to be able to talk to participants without being seen. Individual participants completed the ER on their personal computers one at a time, with 3 pairs doing so on separate computers from different locations and 2 pairs using the same computer with a shared avatar (Figure 2). During the implementation, some technical problems were encountered by a few participants, mostly related to connectivity and navigation.



(**a**) (**b**)

Figure 2. Snapshots from the implementation process. (**a**) An individual player deciphering the second puzzle. (**b**) A pair using a shared avatar, solving the third activity.

After completing the escape room, the debriefing took place, lasting approximately 10 min per session and concluding the live meeting. Then, participants were sent the link to the learning experience questionnaire, which they were asked to complete immediately after. The post-test was completed exactly one week after they participated in the ER. The two focus group sessions took place once the desired number of participants from each condition had completed the ER, attempting to avoid long delays between the ER intervention and focus group sessions. They were conducted in the participants' native language to ensure clear communication, minimise misunderstandings and create a comfortable environment for everyone.

3. Results

3.1. Demographics

From the total of 20 participants, 12 (60%) were female and 8 (40%) were male, while the predominant age group was between 25 and 29 years old, accounting for 75% of the population (n = 15), with three participants being 30–39 (15%) and two being 18–24 years old (10%). Gender-wise, participants were equally split in the control group, whereas in the experimental condition, there were seven female and three male participants (Figure 3). Age distribution was fairly similar between the two groups (Figure 4).

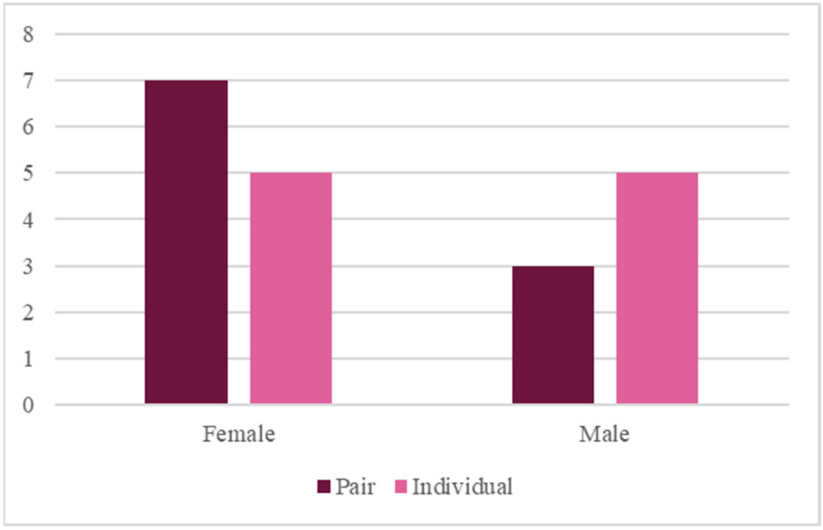


Figure 3. Gender distribution across the different conditions.

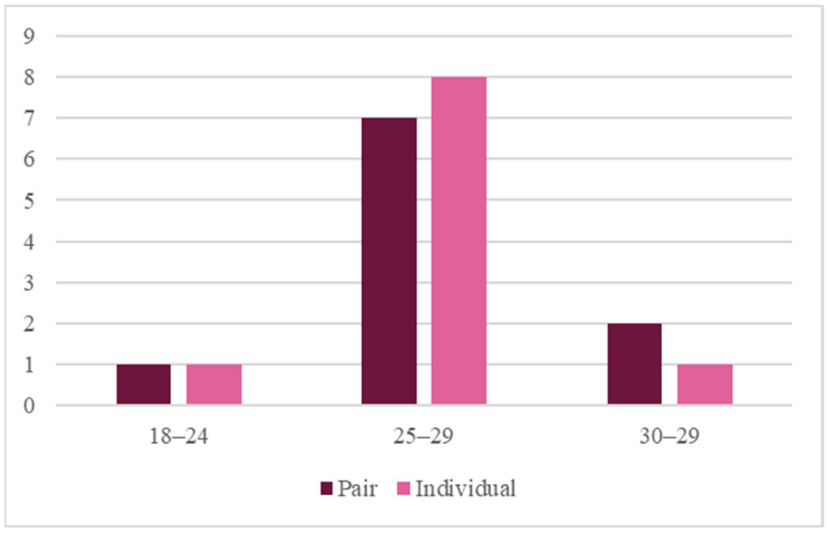


Figure 4. Age distribution across the different conditions.

3.2. Academic Performance

In terms of academic performance, overall, both groups improved (Figure 5), except for two learners in the control group, who scored the same both in the pre-test and in the post-test. A Wilcoxon signed-rank test comparing the pre- and post-test results of each group indicated a statistically significant difference for both pairs ($p = 0.005 < 0.05$) and individuals ($p = 0.011 < 0.05$). Looking at the mean score for each one of the groups, both started with a mean pre-test score of 8.50, but the post-test mean score for pairs was 12.50, whereas for individuals, it was 11.10. Performing a Mann–Whitney U-test on the post-test scores of the two groups showed a statistically significant difference ($p = 0.041 < 0.05$), indicating that the group in which learners worked collaboratively had a better final performance. However, when performing the same test on the difference in pre- and post-test scores between the two groups, the results showed a p value greater than 0.05 ($p = 0.069$), which means that there was no statistically significant difference in improvement between the two groups.

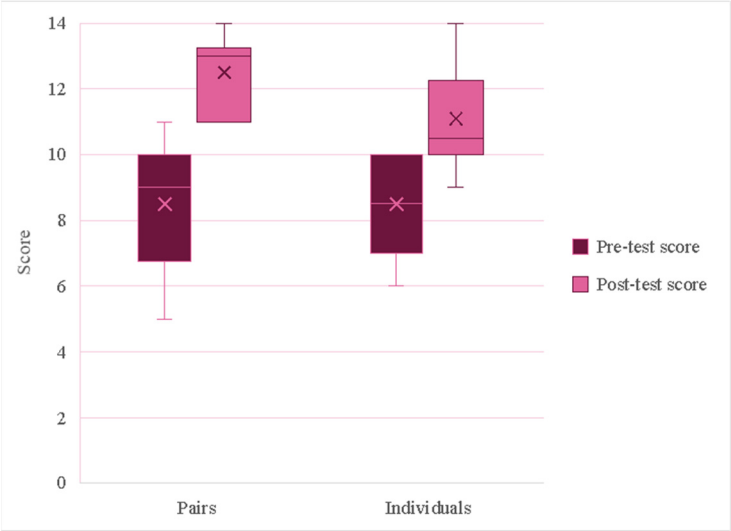


Figure 5. Comparison of participants' pre- and post-test scores.

3.3. Perceived Learning Effectiveness

Based on the results from the learning experience questionnaire, it appears that learners who completed the VRER in pairs had slightly better perceptions regarding their learning effectiveness compared to those who played individually (Figure 6). Q1 was a reverse question, reading, "The VRER did not help me learn a lot". Participants of both groups seemed to agree on the fact that this was not the case by rating the statement with an average of 1.2. In general, all questions yielded positive results for both groups, indicating that both pairs and individual learners consider the VRER an effective learning method. However, running a Mann–Whitney U-test on the overall construct of perceived learning effectiveness by calculating the mean for each question revealed no statistically significant difference ($p = 0.132 > 0.05$) between pairs and individuals. It should be noted that, for all categories, reverse questions were taken into consideration, and their score items were reversed before running the tests to ensure that the results reflect the true differences between groups.

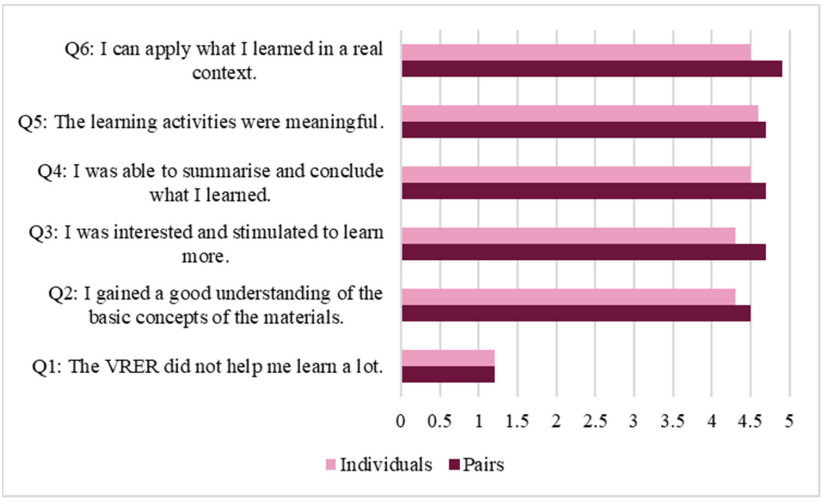


Figure 6. Questionnaire results on perceived learning effectiveness.

3.4. Perceived Cognitive Benefits

The same pattern is observed for perceived cognitive benefits, with all items revealing an overall positive rating (≥4.2) for both groups and learners in pairs exhibiting slightly

higher ratings (Figure 7). From individual results, what stands out is the answer of one participant working in a pair, who adopted a neutral stance towards the fact that the VRER made comprehension and memorisation easier, rating both items with 3. Despite the overall more positive ratings of people working in pairs, the difference was still not statistically significant ($p = 0.134 > 0.05$).

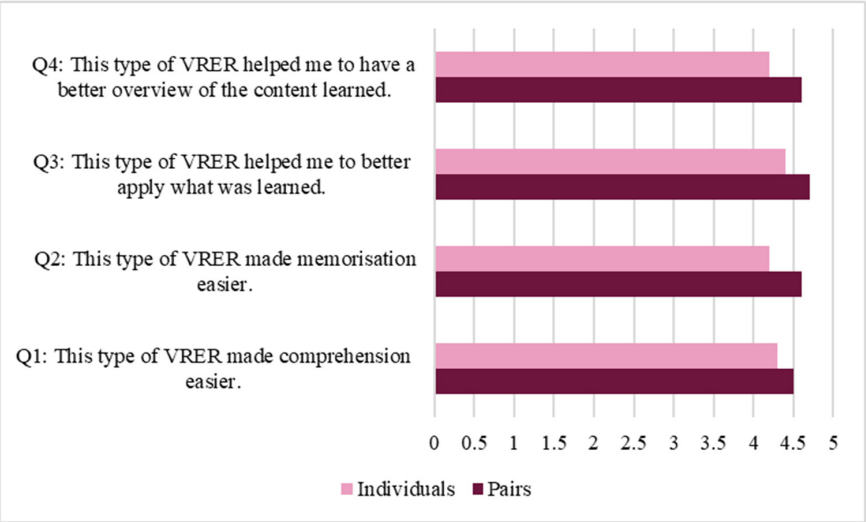


Figure 7. Questionnaire results on perceived cognitive benefits.

3.5. Engagement and Control over the Learning Process

Similar results are reported for the 'control and active learning' construct (Figure 8), with the Mann–Whitney U-test indicating a non-statistically significant difference ($p = 0.094 > 0.05$). However, it is clear which question refers to control (Q2) and which ones refer to learners' active engagement and participation in the learning process (Q1, Q3). Therefore, given the obvious difference that can be observed in Figure 8, it was deemed appropriate to also conduct the test separately for question 2 and for questions 1 and 3. The results showed no statistically significant difference in learners' control over the learning process ($p = 0.687 > 0.05$); however, learners who worked in pairs appeared to be significantly more engaged and active in the learning process ($p = 0.025 < 0.05$) than those who worked individually.

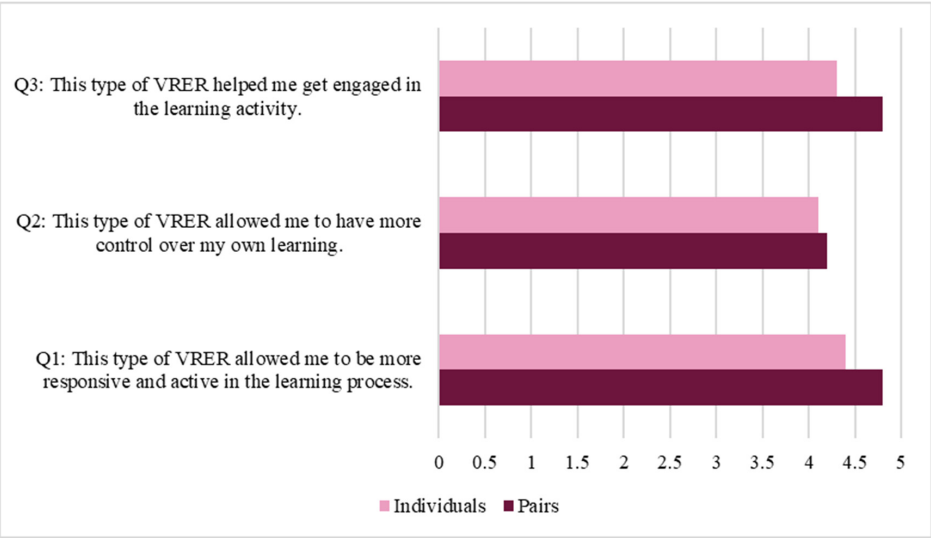


Figure 8. Questionnaire results on control and active learning.

3.6. Affective Factors: Motivation and Satisfaction

When it comes to motivation, it seems that overall, both groups were satisfactorily motivated, with learners working in pairs being a bit more motivated than those who worked alone (Figure 9). What is interesting to note here is that for Q1, "I enjoyed this VR educational escape room very much.", the mean rating of individuals (4.6) was slightly higher than that of pairs (4.5). This difference is explained by the fact that one participant from the pairs rated the question with 2, significantly affecting the mean score. Nonetheless, the same participant rated the rest of the questions with 4 or 5 and the reverse questions with 1 or 2, suggesting, perhaps, that the first answer was a mistake. Another noteworthy answer was that of an individual participant who stated that they strongly agreed with the fact that they felt pressured while learning in this VRER. Despite the overall better ratings of participants working in pairs, a p value of 0.071 showed no statistically significant difference between the two groups.

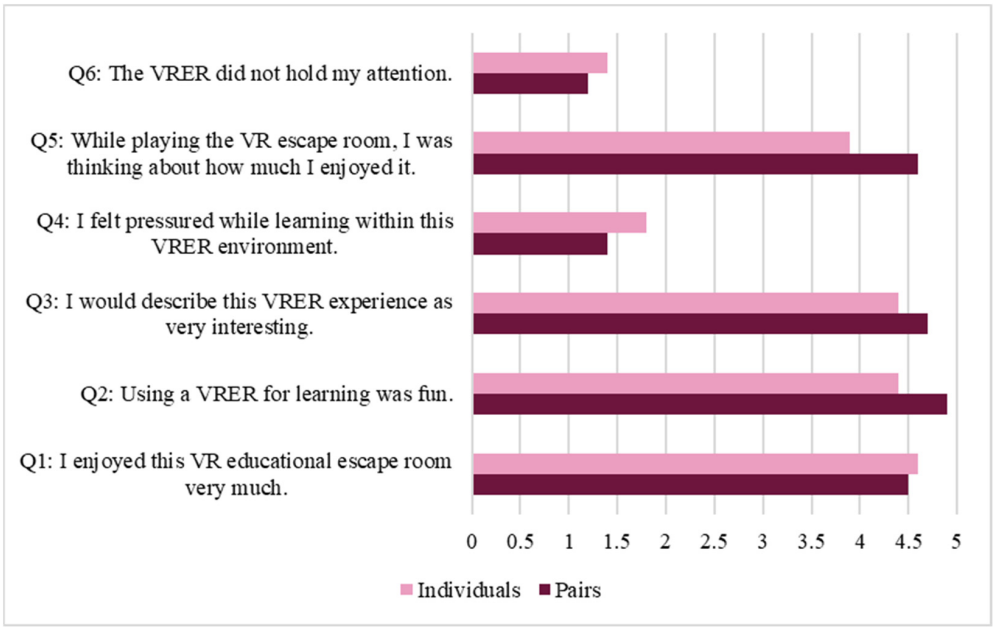


Figure 9. Questionnaire results on motivation.

Finally, for satisfaction, which was the last construct of the learning experience questionnaire, results did not differ compared to the rest of the constructs; both groups of learners were generally satisfied with the experience, with those working in pairs exhibiting slightly higher levels of satisfaction (Figure 10) but not statistically significant ($p = 0.123 > 0.05$).

3.7. Focus Group Results

The results from the two focus groups revealed that half of the participants had played an escape room game before (Figure 11), but never online and not for educational purposes.

Regarding their level of familiarity with VR, participants from both groups reported that they were familiar with the notion, but none of them had ever tried immersive VR. Even though some participants had played online games that incorporated elements of VR in 3D environments, most were unsure about whether their previous experiences qualified as true virtual reality.

Overall, they were overwhelmingly positive about the VRER experience, with both individual (I) and paired (P) participants expressing excitement and enthusiasm. Those in the pair condition, in particular, reported higher levels of enjoyment, possibly due to the social and interactive aspects of working together. Participants who worked individually

also had very positive comments about the experience, focusing on the gamified nature of the escape room.

(P): "It was amazing. I wish teachers would do something like that when we were at school".

(P): "I had so much fun. It is actually the first time ever that I was so motivated to do something related to English".

(I): "Wow. . . It was awesome. I was so invested in the plot".

(I): "I had never imagined you could play an escape room online and make it so exciting".

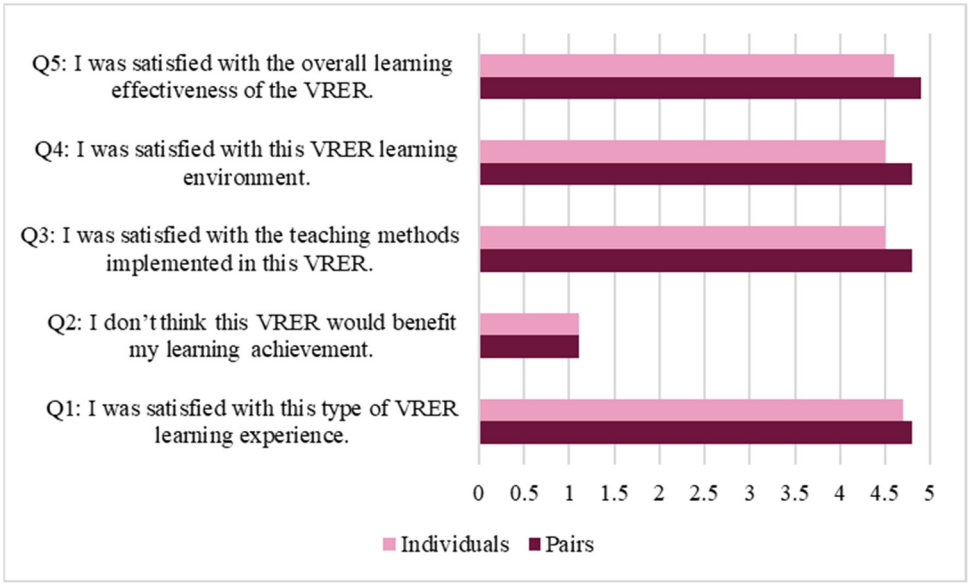


Figure 10. Questionnaire results on satisfaction.

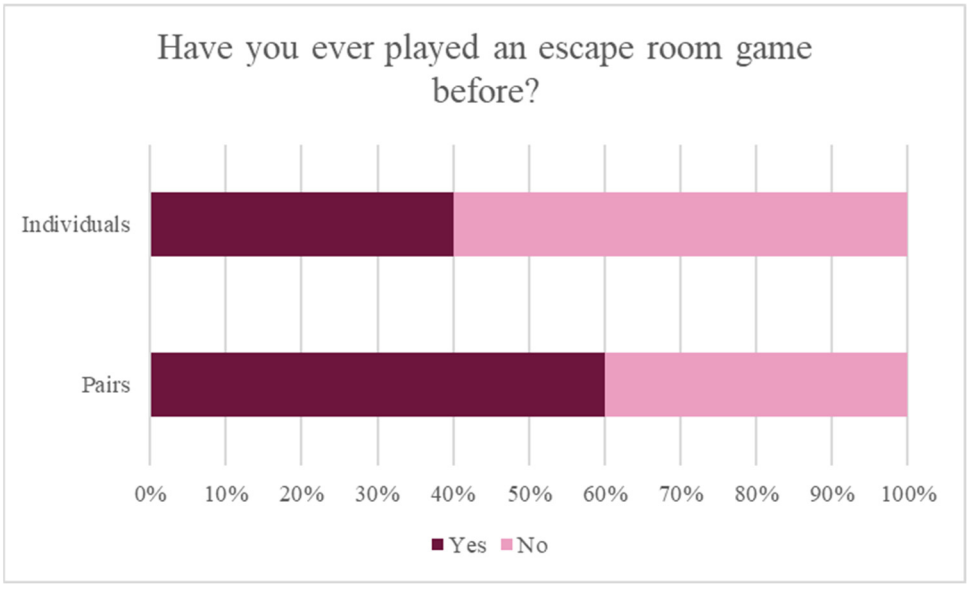


Figure 11. Participants' experience with escape rooms.

Both groups felt involved in the learning process, but the pair participants reported a deeper sense of engagement, similar to the results from the questionnaire, while also reporting high levels of motivation within this context. For individuals, the experience was engaging, but they occasionally reported the absence of social interaction.

(P): "I was super motivated because [my partner] kept pushing me to think harder".

(P): "It was very engaging. So much better than just sitting in a classroom and listening to a teacher".

(I): "Typically escape rooms are for teams. I missed having someone else there. I don't think having too many people would have worked out because it was online, but like one or two more".

On the contrary, there were also individual participants who preferred working alone and would not have wanted anyone else in the room. They even stated that working alone gave them a bigger sense of accomplishment.

(I): "It was so much better working alone. I took my time [...]. And I didn't have anyone to disagree or argue with".

(I): "Now, I managed to escape on my own and I am very proud of myself. I don't think I would have felt the same sense of accomplishment if I had worked in a team".

In terms of participants' learning effectiveness, both pairs and individuals reported positive results. Particularly, learners in pairs focused on the implicit learning that took place while playing the VRER. Individual learners also perceived the experience to be useful in helping them acquire new knowledge, with one participant stating that they were not sure if they would be able to retain that knowledge.

(P): "You learn without realising it".

(I): "Yeah, I think it helped actually learn the new vocabulary. Don't ask me if I'll remember it in a month. Probably not... But still, it was helpful".

Regarding the challenges participants faced while playing, some technical issues were reported by both groups, at times disrupting immersion. There were also some recommendations for improving the experience.

(P): "I wish I could see the timer the whole time we were in the room".

(I): "At times, it was too quiet. Some background music or some more sound effects would have helped".

All in all, participants of both groups seem to have had a positive experience, with learners in pairs reporting on it with more enthusiasm, highlighting the positive aspects of working with a teammate. Moreover, both conditions led to positive learning outcomes, demonstrating the VRER's potential to be effective in both collaborative and individual settings.

4. Discussion

4.1. Learning Outcomes: Perceptions vs. Actual Performance and the Effect of Collaboration

The results of the study indicated that learners' academic performance improved after playing the escape room, a finding that aligns with previous research [26,29,30,32,39], underscoring the potential for an interactive and playful environment to lead to positive learning outcomes. These improvements were overall evident across both conditions, suggesting that regardless of whether learners worked individually or collaboratively, the Metaverse VRER experience positively impacted their performance. On the other hand, the mode of collaboration did not have an impact on learning outcomes, as there was no difference in pre- and post-test scores between pairs working remotely and those working face-to-face. These outcomes hold considerable relevance, given that this is one of the first attempts at integrating virtual reality with EFL education in the context of an educational escape room. The positive results from both conditions suggest that teachers could implement Metaverse VRERs as supplementary tools to cater to different learner preferences, thereby personalising instruction and enhancing learning outcomes. Moreover, the adaptability of VRERs means they can be used in both face-to-face and online learning

environments, offering flexibility for teachers dealing with varied classroom settings or remote teaching scenarios.

Learners' positive perceptions of their learning effectiveness also agree with previous findings [25,30,32,37,38,42], highlighting the fact that they consider Metaverse VR educational escape rooms to be an effective teaching and learning method. It is important to note that their perceptions of their learning also reflected their actual performance, further reinforcing the validity of the escape room as an effective educational tool. In general, participants found the learning activities meaningful, while the interactive, game-based approach provided opportunities for practical application, which learners identified as beneficial for acquiring the target vocabulary.

Moreover, the study's results showed that learners' perceived cognitive benefits also improved, supporting the notion that educational escape rooms can enhance cognitive engagement [40] by fostering problem-solving and critical thinking skills in an authentic, low-stress environment. The escape room can, therefore, also prove to be an opportunity for meaningful learning, which occurs when learners can transfer their new knowledge to new situations [61]. Thus, the positive effects of the VRER on both perceived and actual learning outcomes emphasise its value as an effective method for EFL teaching and learning.

However, when it comes to comparing the results of the two groups, namely collaborative and non-collaborative, which was the initial aim of this study, things become less clear. Learners who played the escape room in pairs seemed to do better in the post-test than those who played individually. Nonetheless, there was no statistically significant difference in learners' improvement between the two groups. This contradictory finding can be explained by taking into account the small sample size of the study. Having only twenty participants means that even a slight difference in post-test scores, such as the one found here (1.4), could show up as significant, but the improvement might be harder to distinguish statistically due to improvement scores being relatively close between participants in the two groups. In addition to that, despite perceptions of learning effectiveness and cognitive benefits being higher in learners who worked collaboratively, the differences are still not significant enough to be able to conclude with certainty that the collaborative condition is more effective. It is also noteworthy that, for these two constructs, the perceptions of learners who collaborated remotely were slightly better than those collaborating face-to-face, perhaps suggesting that the mode of collaboration can play a role in how learners perceive the overall learning impact of the experience.

It is undeniable that collaboration in the EFL context can have a number of benefits, including improving learners' performance [62] and positively impacting their engagement [63], as well as teachers' and learners' perceptions [64]. Therefore, despite the fact that no safe conclusions can be drawn as to the effectiveness of collaboration over a non-collaborative learning environment in the context of VRERs, the results of the study can serve as a basis for future research on the implementation of VR escape rooms in EFL education.

4.2. Learning Experience: Motivation, Satisfaction, Engagement and Control over the Learning Process

As expected, both groups reported an overall positive learning experience. In line with previous findings, this study highlights the positive impact of the VRER on learners' engagement [24,31,34,44], motivation [27–30,32,33] and satisfaction [29,44], but also on learners' control over the learning process. When it comes to comparing the two groups, pairs exhibited higher levels in all aspects of the learning experience; however, only results on engagement showed a statistically significant difference. Therefore, we can conclude that learners who worked collaboratively felt more engaged and active in the learning process. Results are further enhanced by the qualitative data, indicating that learners who worked

collaboratively reported on the experience with more enthusiasm, highlighting the positive outcomes of working in a pair. Even though there were also a few participants stating that they preferred working alone, their quantitative results on learning performance and experience were not better than those of learners working in pairs, suggesting, perhaps, that the benefits of collaboration in this context outweigh individual preferences and may provide a more effective learning environment overall. In addition to that, the mode of collaboration could potentially impact the learning experience, as quantitative data showed that pairs working remotely exhibited slightly higher motivation compared to pairs sharing the same computer, but their satisfaction, engagement and control levels were lower.

Although the sample size of the current research is too small to be able to draw definitive conclusions, the results indicate a clear trend: learners who work collaboratively in an EFL VR escape room experience tend to exhibit better learning outcomes and higher levels of engagement, motivation and satisfaction, as well as experience a positive effect on their perceived cognitive benefits, perceived learning outcomes and a greater sense of control over the learning process.

4.3. Implications

The insights of the present study can contribute to the academic discourse on immersive learning while also offering valuable takeaways for educators seeking innovative approaches to improve student engagement and learning effectiveness in language education. Understanding how collaborative learning in a Metaverse VR escape room can affect EFL learners offers a new perspective on the role of interactive technologies in language learning. The results highlight the importance of creating interactive and socially driven learning experiences, aligning with the notion that active participation and peer interaction are key components of effective learning environments. The study also suggests that immersive technologies like VR and the Metaverse may help bridge the gap between language acquisition and practical application, offering learners a more dynamic and meaningful way to develop language skills. These implications could inspire further research into collaborative, immersive learning tools for language education.

Furthermore, from a practical perspective, incorporating VR-based collaborative tasks in EFL education could allow educators to foster higher levels of motivation, engagement and satisfaction by providing learners with opportunities to engage in team-based problem-solving. In this context, learners also stated that they felt more in control of the learning process, which could also foster a deeper sense of learner autonomy as the teacher transitions from transmitting information to facilitating learning, guiding them towards self-directed exploration and decision-making [65]. This enhanced sense of autonomy can make the VRER an attractive alternative to more conventional methods. Ultimately, these findings could influence the design of future language curricula, promoting more interactive and technology-driven learning solutions to meet the evolving needs of students. For institutions, adopting such tools could lead to better overall learning experiences and outcomes, fostering an environment where students feel both challenged and supported.

5. Conclusions

This study aimed to explore the effects of collaboration within a VR escape room environment in the Metaverse on learners' academic performance and learning experience in the context of English as a Foreign Language. The research provided valuable insights into the potential of immersive, collaborative learning experiences to positively affect both the educational and emotional aspects of language acquisition. As the field of immersive learning continues to grow, future research is necessary to enhance the applicability of these findings and to expand their impact across different educational contexts. In order

to offer pathways for advancing this area of study, it is also essential to acknowledge the limitations of the current research, which can be identified both in the development and application of the escape room as well as in the execution of the study itself.

First of all, a significant limitation is the small number and uneven gender distribution of participants recruited for this study, which makes it difficult to generalise the findings beyond this specific context. To address this, future research should include larger sample sizes and consider testing different populations in various educational settings to ensure broader applicability. Additionally, taking into account that collaboration can sometimes have drawbacks, such as personality clashes or unequal contribution, and that working preferences can vary among individuals, it becomes evident that further research is needed to explore how specific learner characteristics—such as comfort with collaboration, personal relationships and working styles—impact collaborative learning environments. It is also important to acknowledge that the study used different interaction methods for the collaborative condition, namely remote and face-to-face, to accommodate more participants, which may have impacted the results. Therefore, future studies should specifically investigate different modes of collaboration but also varying group sizes to understand how these factors shape interaction dynamics and influence the effectiveness of educational VRERs in the Metaverse.

Another limitation is that, although the study used mixed methods, i.e., both qualitative and quantitative data to examine learners' perceived and actual learning gains, respectively, the absence of a delayed post-test to compare the long-term effects of the intervention limits the ability to assess the retention of knowledge or sustained impact of the intervention over time in either one of the conditions. This would be an important aspect to include in future research to assess whether learning gains persist over time. Furthermore, this study relied on a single VR escape room session. On the one hand, additional sessions could help students become more confident with the Metaverse platforms, allowing them to focus more on the learning content and less on managing the technology. On the other hand, research on virtual reality learning often observes a novelty effect, where initial enthusiasm can lead to high engagement, but this effect usually diminishes with repeated exposure [66]. Thus, future studies could also examine how repeated utilisation of virtual reality escape rooms could affect learning outcomes, engagement, and motivation over time.

Some technical difficulties also posed challenges during the study, particularly for learners with lower-end devices or limited technological experience. These issues may have impacted their overall experience and responses, highlighting the importance of thoroughly testing VR environments before implementation in real educational settings to mediate such instances. However, designing high-quality environments is not as straightforward. It heavily depends on the technical expertise of the designer, who is usually a teacher with limited programming skills, as well as on the VR development tools, which often have their own limitations. For instance, in this study, the environment had to be broken into four Frames, requiring learners to reconnect as they transitioned between Frames, which may have disrupted their sense of immersion and ultimately affected the results. The time, resources and technological infrastructure required for both the design and implementation phases are also significant considerations. When incorporating such interventions into real educational contexts, it is crucial to choose the appropriate technology—whether immersive or non-immersive VR—to suit the specific educational setting. This decision impacts not only the quality of the learning experience but also the practicality of integrating the technology into daily physical and online classroom use. Therefore, it is essential to train educators not only in designing high-quality interactive environments but also in how to

strategically implement such interventions in the learning process, taking into consideration all the necessary aspects.

Author Contributions: Conceptualisation, A.-M.P. and S.M.; methodology, A.-M.P. and S.M.; software, A.-M.P.; validation, A.-M.P. and S.M.; formal analysis, A.-M.P.; investigation, A.-M.P.; resources, S.M.; data curation, A.-M.P.; writing—original draft preparation, A.-M.P. and S.M.; writing—review and editing, S.M. and I.K.; visualisation, A.-M.P.; supervision, S.M. and I.K.; project administration, S.M.; funding acquisition, I.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The data are available here: https://zenodo.org/records/14592441 (accessed on 17 November 2024).

Acknowledgments: The first author would like to thank the instructors of the online MSc and Phd program in Immersive Technologies–Innovation in Education, Training and Game Design of the Department of Computer Science at the Democritus University of Thrace, Greece.

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

Appendix A

Table A1. Pre-test & Post-test questions.

Instructions
Complete the following examples by choosing the answer you think is correct.
Pre-test
4-digit code: Choose a random 4-digit code. It is very important that you remember this code, as you will need to use it in two more questionnaires (one completed after the escape room and one completed a week later).
Post-test
4-digit code: Use the same 4-digit code that you used in the pre-test and the questionnaire.
Note: correct answers are marked in bold

1. The film was criticised for being too _____, with an unoriginal plot that had no surprises and an ending that could be guessed within the first 20 min. [a. captivating, b. intricate, c. **predictable**, d. compelling]
2. The plot was so _____. Nothing _____ happened throughout the entire film. I almost fell asleep. What a waste of time and money. [a. intricate. . . mediocre, b. captivating. . . interesting, c. **dull. . . intriguing**, d. extraordinary. . . compelling]
3. Which term refers to "the art of film photography, the process of planning and executing the visual aspects of a film"? [a. **cinematography**, b. audience, c. resolution, d. foreshadowing]
4. The novel's _____ plot with its complex character relationships and twists, required careful attention to detail from the reader to fully understand the story. [a. underwhelming, b. blockbuster, c. **intricate**, d. dull]
5. The actors went through several _____ before the final performance to practise and perfect their scenes and ensure the best possible outcome. [a. narratives, b. leading characters, c. **rehearsals**, d. blockbusters]
6. The critic described the film as _____, noting that the _____ was weak as there was nothing interesting going on. [a. extraordinary. . . plot, b. **mediocre. . . narrative**, c. captivating. . . scenario, d. dull. . . audience]
7. The final scene was _____, failing to deliver the excitement that the build-up promised and disappointing everyone who was waiting for a plot twist. [a. a blockbuster, b. intriguing, c. compelling, d. **underwhelming**]
8. The novel's _____ plot, with its unexpected twists and deep character development, made it hard for readers to put the book down. [a. foreshadowing, b. predictable, c. mediocre, d. **captivating**]
9. What is the best definition for "audience"? [a. **The group of people who watch a performance or film.**, b. The complexity of the plot., c. The stage where the performance takes place., d. The storyline of a film.]

Table A1. *Cont.*

10. The _____ film "Barbie" sold more than 1 billion tickets after just 2 weeks in cinemas, breaking box office records and becoming one of the most successful films of the decade. [a. mediocre, b. **blockbuster**, c. intricate, d. resolution]
11. Her performance was _____, leaving the viewers amazed and setting her apart from others in the film industry. [a. mediocre, b. dull, c. **extraordinary**, d. intricate]
12. The _____ in the film was played by a famous actor who managed to bring to life an iconic historical figure by putting up such a(n) _____ performance. [a. audience. . . amazing, b. **leading character. . . compelling**, c. resolution. . . extraordinary, d. foreshadowing. . . mediocre]
13. Which word best matches the definition: "An event or scene that hints at events that will happen later in a story"? [a. **foreshadowing**, b. rehearsal, c. narrative, d. cinematography]
14. The _____ of the film answered all the questions and provided a satisfying ending. [a. blockbuster, b. audience, c. **resolution**, d. cinematography]

Table A2. Demographics & Learning experience evaluation questionnaire.

Instructions: The present questionnaire aims at evaluating your learning experience after having completed the Virtual Reality Escape Room (VRER). It consists of six parts. The first part relates to general demographic data. Parts 2–6 consist of statements related to the levels of motivation, the cognitive benefits, control and active learning, perceived learning effectiveness and satisfaction. Please respond to the questionnaire by stating your level of agreement with the statements. The completion of the questionnaire will take approximately 15 min. Thank you in advance for your participation!

4-digit code: Use the same 4-digit code that you used in the pre-test. It is very important that you ***remember this code***, as you will need to use it in ***one more questionnaire*** (completed a week later).

Demographics

1. Please state your gender. [a. Female, b. Male, c. Other]
2. Please state your age group. [a. 18–24, b. 25–29, c. 30–39, d. 40–49, e. 50–59, f. 60+]
3. Did you play the escape room alone or in a pair? [a. Alone, b. In a pair]

Learning Experience Evaluation Questionnaire

5-point Likert scale [1. strongly disagree, 2. disagree, 3. neutral, 4. agree, 5. strongly agree]

Motivation

1. I enjoyed this VR educational escape room very much.
2. Using a VRER for learning was fun.
3. I would describe this VRER experience as very interesting.
4. I felt pressured while learning within this VRER environment. (R)
5. While playing the VR escape room, I was thinking about how much I enjoyed it.
6. The VRER did not hold my attention. (R)

Cognitive benefits

1. This type of VRER made comprehension easier.
2. This type of VRER made memorisation easier.
3. This type of VRER helped me to better apply what was learned.
4. This type of VRER helped me to have a better overview of the content learned.

Control and active learning

1. This type of VRER allowed me to be more responsive and active in the learning process.
2. This type of VRER allowed me to have more control over my own learning.
3. This type of VRER helped me get engaged in the learning activity.

Table A2. *Cont.*

Perceived learning effectiveness
1. The VRER did not help me learn a lot. (R)
2. I gained a good understanding of the basic concepts of the materials.
3. I was interested and stimulated to learn more.
4. I was able to summarise and conclude what I learned.
5. The learning activities were meaningful.
6. I can apply what I learned in a real context.
Satisfaction
1. I was satisfied with this type of VRER learning experience.
2. I don't think this VRER would benefit my learning achievement. (R)
3. I was satisfied with the teaching methods implemented in this VRER.
4. I was satisfied with this VRER learning environment.
5. I was satisfied with the overall learning effectiveness of the VRER.

(R): reverse question.

Table A3. Focus group questions.

1. Introduce yourselves to the group.
2. How familiar are you with VR?
3. Have you ever played an escape room game before?
4. Tell us about your overall impression of the VRER experience.
5. What would you say were the main challenges you faced while working in the VR escape room?
6. How involved did you feel in the learning process? Were there moments where you felt particularly engaged?
7. Can you share which parts of the game made you feel motivated while playing?
8. How do you feel about the overall learning experience? Do you think it was effective in helping you achieve your learning goals?
9. Is there anything else we should have talked about but didn't?

References

1. Kuhail, M.A.; ElSayary, A.; Farooq, S.; Alghamdi, A. Exploring Immersive Learning Experiences: A Survey. *Informatics* **2022**, *9*, 75. [CrossRef]
2. Sandoval-Henríquez, F.J.; Sáez-Delgado, F.; Badilla-Quintana, M.G. Systematic Review on the Integration of Immersive Technologies to Improve Learning in Primary Education. *J. Comput. Educ.* **2024**. [CrossRef]
3. Turan, Z.; Karabey, S.C. The Use of Immersive Technologies in Distance Education: A Systematic Review. *Educ. Inf. Technol.* **2023**, *28*, 16041–16064. [CrossRef] [PubMed]
4. Lege, R.; Bonner, E. Virtual Reality in Education: The Promise, Progress, and Challenge. *JALT CALL J.* **2020**, *16*, 167–180. [CrossRef]
5. McGovern, E.; Moreira, G.; Luna-Nevarez, C. An Application of Virtual Reality in Education: Can This Technology Enhance the Quality of Students' Learning Experience? *J. Educ. Bus.* **2020**, *95*, 490–496. [CrossRef]
6. Villena-Taranilla, R.; Tirado-Olivares, S.; Cózar-Gutiérrez, R.; González-Calero, J.A. Effects of Virtual Reality on Learning Outcomes in K-6 Education: A Meta-Analysis. *Educ. Res. Rev.* **2022**, *35*, 100434. [CrossRef]
7. Yu, Z.; Xu, W. A Meta-Analysis and Systematic Review of the Effect of Virtual Reality Technology on Users' Learning Outcomes. *Comput. Appl. Eng. Educ.* **2022**, *30*, 1470–1484. [CrossRef]
8. van der Meer, N.; van der Werf, V.; Brinkman, W.-P.; Specht, M. Virtual Reality and Collaborative Learning: A Systematic Literature Review. *Front. Virtual Real.* **2023**, *4*, 1159905. [CrossRef]
9. Alizadehsalehi, S.; Hadavi, A.; Huang, J.C. From BIM to Extended Reality in AEC Industry. *Autom. Constr.* **2020**, *116*, 103254. [CrossRef]
10. Musa, M.; Rahman, P.; Buhalis, D. Virtual Reality (VR) Types. In *Encyclopedia of Tourism Management and Marketing*; Edward Elgar: Cheltenham, UK, 2022; pp. 679–683. ISBN 978-1-80037-747-9.
11. Ritterbusch, G.D.; Teichmann, M.R. Defining the Metaverse: A Systematic Literature Review. *IEEE Access* **2023**, *11*, 12368–12377. [CrossRef]
12. Mystakidis, S.; Lympouridis, V. Immersive Learning Design in the Metaverse: A Theoretical Literature Review Synthesis. In *Application of the Metaverse in Education*; Liu, D., Huang, R., Metwally, A.H.S., Tlili, A., Lin, E.F., Eds.; Springer: Berlin/Heidelberg, Germany, 2024; pp. 55–71.

13. Nicholson, S. Peeking Behind the Locked Door: A Survey of Escape Room Facilities. 2015. Available online: http://scottnicholson.com/pubs/erfacwhite.pdf (accessed on 17 November 2024).
14. Yazdi, A.; Karimi, A.; Mystakidis, S. Gamification in Online Education: A Visual Bibliometric Network Analysis. *Information* **2024**, *15*, 81. [CrossRef]
15. Maher, K. Historical Escape Rooms: Unlocking the Potential for Communication and Collaboration in History Lessons. Master's Thesis, National University of Ireland Maynooth, Kildare, Ireland, 2022.
16. Fotaris, P.; Mastoras, T. Escape Rooms for Learning: A Systematic Review. In *Proceedings of the European Conference on Games-Based Learning*; Elbaek, L., Majgaard, G., Valente, A., Khalid, S., Eds.; Academic Conferences and Publishing International Limited: Reading, UK, 2019; pp. 235–243.
17. Taraldsen, L.H.; Haara, F.O.; Lysne, M.S.; Jensen, P.R.; Jenssen, E.S. A Review on Use of Escape Rooms in Education—Touching the Void. *Educ. Inq.* **2022**, *13*, 169–184. [CrossRef]
18. Tercanli, H.; Martina, R.; Ferreira Dias, M.; Wakkee, I.; Reuter, J.; Amorim, M.; Madaleno, M.; Magueta, D.; Vieira, E.; Veloso, C.; et al. *Educational Escape Rooms in Practice: Research, Experiences, and Recommendations*; Universidade de Aveiro: Kildare, Ireland, 2021; ISBN 978-972-789-681-3.
19. Veldkamp, A.; van de Grint, L.; Knippels, M.-C.P.J.; van Joolingen, W.R. Escape Education: A Systematic Review on Escape Rooms in Education. *Educ. Res. Rev.* **2020**, *31*, 100364. [CrossRef]
20. Gunawan, A.; Wiranto, N.; Wu, D. Application of Virtual Reality in Diverse Fields of Study in Education Sector: A Systematic Literature Review. *Procedia Comput. Sci.* **2023**, *227*, 948–957. [CrossRef]
21. Radianti, J.; Majchrzak, T.A.; Fromm, J.; Wohlgenannt, I. A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, and Research Agenda. *Comput. Educ.* **2020**, *147*, 103778. [CrossRef]
22. Arik, E.; Arik, B. The Different Aspects of English Language Teaching and Learning: A Scientometric Analysis. *J. Scientometr. Res.* **2021**, *10*, 84–93. [CrossRef]
23. Makri, A.; Vlachopoulos, D.; Martina, R.A. Digital Escape Rooms as Innovative Pedagogical Tools in Education: A Systematic Literature Review. *Sustainability* **2021**, *13*, 4587. [CrossRef]
24. Darejeh, A. Empowering Education through EERP: A Customizable Educational VR Escape Room Platform. In Proceedings of the 2023 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct), Sydney, Australia, 16–20 October 2023; pp. 764–766.
25. Haramina, E.; Paladin, M.; Petričušić, Z.; Posarić, F.; Drobnjak, A.; Botički, I. Learning Algorithms Concepts in a Virtual Reality Escape Room. In Proceedings of the 2024 47th MIPRO ICT and Electronics Convention (MIPRO), Opatija, Croatia, 22–26 May 2023; pp. 2057–2062.
26. Hui, M.T.R.; Liu, S.; Qiu, Y.; Zhu, G.; Fan, X. A Virtual Reality Escape Room Game for Learning Computer Architecture Concepts. In *Proceedings of the Intelligent Autonomous Systems 18*; Lee, S.-G., An, J., Chong, N.Y., Strand, M., Kim, J.H., Eds.; Springer Nature: Cham, Switzerland, 2024; pp. 385–397.
27. Mateen, S.; Wiesemüller, P.; Voß-Nakkour, S. Access to Escape: Didactic Conception and Accessible Game Design of a VR-Escape Room for Accessibility Education. *Int. J. Adv. Intell. Syst.* **2023**, *16*, 113–126.
28. Wiesemüller, P.; Mateen, S.; Dengel, A.; Voß-Nakkour, S. Access to Escape—An Immersive Game-Based Learning Experience for Accessibility Education in Virtual Reality. In Proceedings of the Immersive Learning Research Network; Bourguet, M.-L., Krüger, J.M., Pedrosa, D., Dengel, A., Peña-Rios, A., Richter, J., Eds.; Springer Nature: Cham, Switzerland, 2024; pp. 273–288.
29. Christopoulos, A.; Mystakidis, S.; Cachafeiro, E.; Laakso, M.-J. Escaping the Cell: Virtual Reality Escape Rooms in Biology Education. *Behav. Inf. Technol.* **2023**, *42*, 1434–1451. [CrossRef]
30. Mystakidis, S.; Cachafeiro, E.; Hatzilygeroudis, I. Enter the Serious E-Scape Room: A Cost-Effective Serious Game Model for Deep and Meaningful E-Learning. In Proceedings of the 2019 10th International Conference on Information, Intelligence, Systems and Applications (IISA), Patras, Greece, 15–17 July 2019; pp. 1–6.
31. Janonis, A.; Kiudys, E.; Girdžiūna, M.; Blažauskas, T.; Paulauskas, L.; Andrejevas, A. Escape the Lab: Chemical Experiments in Virtual Reality. In Proceedings of the Information and Software Technologies; Lopata, A., Butkienė, R., Gudonienė, D., Sukackė, V., Eds.; Springer International Publishing: Cham, Switzerland, 2020; pp. 273–282.
32. Wolf, M.; Montag, M.; Söbke, H.; Wehking, F.; Springer, C. Low-Threshold Digital Educational Escape Rooms Based on 360VR and Web-Based Forms. *Electron. J. E-Learn.* **2024**, *22*, 1–18. [CrossRef]
33. Staneva, A.; Ivanova, T.; Rasheva-Yordanova, K.; Borissova, D. Gamification in Education: Building an Escape Room Using VR Technologies. In Proceedings of the 2023 46th MIPRO ICT and Electronics Convention (MIPRO), Opatija, Croatia, 22–26 May 2023; pp. 678–683.
34. Arbesser-Rastburg, G.; Safikhani, S.; Gustin, M.; Hopfe, C.; Schweiger, G.; Pirker, J. Project Beyond: An Escape Room Game in Virtual Reality to Teach Building Energy Simulations. In Proceedings of the 2024 IEEE Conference on Games (CoG), Milan, Italy, 5–8 August 2024; pp. 1–8.

35. Yeasmin, S.; Albabtain, L.A. Implementation of a Virtual Reality Escape Room Game. In Proceedings of the 2020 IEEE Graphics and Multimedia (GAME), Kota Kinabalu, Malaysia, 17–19 November 2020; pp. 7–12.
36. Heredia Martín, M. The Use of Digital Escape Rooms for Vocabulary Acquisition in the EFL Classroom. Master's Thesis, Universitat Oberta de Catalunya, Barcelona, Spain, 2024.
37. Maroudi, K.M. Introducing Young Adult Literature in the EFL Classroom: A Proposal for the Digital Age. Master's Thesis, Aristotle University of Thessaloniki, Thessaloniki, Greece, 2022.
38. Bellés-Calvera, L.; Martínez-Hernández, A.-I. Slave Away or Get Away: Escape Rooms as a Motivational Tool for the CLIL History Classroom in Higher Education. *Lat. Am. J. Content Lang. Integr. Learn.* **2022**, *15*, e1511. [CrossRef]
39. Rosseli, R. Digital Escape Room as a Tool to Teach Grammar. Master's Thesis, University of Agder, Kristiansand, Norway, Grimstad, Norway, 2023.
40. Voreopoulou, A.; Mystakidis, S.; Tsinakos, A. Augmented Reality Escape Classroom Game for Deep and Meaningful English Language Learning. *Computers* **2024**, *13*, 24. [CrossRef]
41. Moreno-Reyes, J.M.; Alejos, D.J.; Siefker, D.; Martínez-Meza, R. 360 virtual tour and escape room design as a video games-based learning process for diagnosis and strengthening of the English language. *Rev. Tecnol. Informática* **2022**, 1–14. [CrossRef]
42. Senkbeil, K.; Martin, G.; O'Rourke, B. *SpEakWise VR: Exploring the Use of Social Virtual Reality in Telecollaborative Foreign Language Learning between Learners of English and German*; Research-Publishing: Singapore, 2022.
43. Almazova, N.; Rubtsova, A.; Eremin, Y.; Kats, N.; Baeva, I. Tandem Language Learning as a Tool for International Students Sociocultural Adaptation. In *Proceedings of the Integrating Engineering Education and Humanities for Global Intercultural Perspectives*; Anikina, Z., Ed.; Springer International Publishing: Cham, Switzerland, 2020; pp. 174–187.
44. Ioannou, A.; Lemonari, M.; Liarokapis, F.; Aristidou, A. Collaborative VR: Solving Riddles in the Concept of Escape Rooms. In Proceedings of the International Conference on Interactive Media, Smart Systems and Emerging Technologies (IMET), Barcelona, Spain, 5–6 October 2023.
45. de Blecourt, M. The Impact of Virtual Reality on Social Processes in Escape Rooms. Master's Thesis, Utrecht University, Utrecht, The Netherlands, 2022.
46. Yeflach-Wishkerman, V. Perceptions of Pre-Service Teachers While Developing a Virtual Educational Escape Room (VEER) Using Online Collaborative Learning. *Int. J. Educ. Res.* **2024**, *125*, 102348. [CrossRef]
47. Tai, T.-Y.; Chen, H.H.-J.; Todd, G. The Impact of a Virtual Reality App on Adolescent EFL Learners' Vocabulary Learning. *Comput. Assist. Lang. Learn.* **2022**, *35*, 892–917. [CrossRef]
48. Gómez López, Á. The Use of Escape Rooms to Teach and Learn English at University. In *Research, Technology and Best Practices in Education*; Pérez Aldeguer, S., Akombo, D.O., Eds.; Adaya Press: Eindhoven, The Netherlands, 2019; pp. 94–102. ISBN 978-94-92805-09-6.
49. Boykov, V.; Goceva, M. Formal, Non-Formal and Informal Education. *Knowl.–Int. J.* **2019**, *35*.
50. Fotaris, P.; Mastoras, T. Room2Educ8: A Framework for Creating Educational Escape Rooms Based on Design Thinking Principles. *Educ. Sci.* **2022**, *12*, 768. [CrossRef]
51. Bybee, R.; Taylor, J.; Gardner, A.; Scotter, P.; Carlson, J.; Westbrook, A.; Landes, N. *The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications*; BSCS: Colorado Springs, CO, USA, 2006.
52. Ikram, G.; Amira, A. Investigating EFL Teachers' Attitudes Towards the Use of the 5Es Model. Master's Thesis, Guelma University, Guelma, Algeria, 2023.
53. Wu, W.-C.V.; Manabe, K.; Marek, M.W.; Shu, Y. Enhancing 21st-Century Competencies via Virtual Reality Digital Content Creation. *J. Res. Technol. Educ.* **2023**, *55*, 388–410. [CrossRef]
54. Yang, C.-L.; Chang, C.-Y.; Jen, H.-J. Facilitating Undergraduate Students' Problem-Solving and Critical Thinking Competence via Online Escape Room Learning. *Nurse Educ. Pract.* **2023**, *73*, 103828. [CrossRef]
55. Test Your English | Cambridge English. Available online: https://www.cambridgeenglish.org/test-your-english/ (accessed on 7 September 2024).
56. Miri, S.M.; Shahrokh, D.Z. *A Short Introduction to Comparative Research*; Allameh Tabataba'i University: Tehran, Iran, 13 May 2019.
57. Pidel, C.; Ackermann, P. Collaboration in Virtual and Augmented Reality: A Systematic Overview. In *Proceedings of the Augmented Reality, Virtual Reality, and Computer Graphics*; De Paolis, L.T., Bourdot, P., Eds.; Springer International Publishing: Cham, Switzerland, 2020; pp. 141–156.
58. Ramakrishnan, V.; Nanthagopan, Y. Review and Comparison of MultiMethod and Mixed Method Application in Research Studies. *Eur. J. Manag. Issues* **2021**, *29*, 200–208.
59. Ai-Lim Lee, E.; Wong, K.W.; Fung, C.C. How Does Desktop Virtual Reality Enhance Learning Outcomes? A Structural Equation Modeling Approach. *Comput. Educ.* **2010**, *55*, 1424–1442. [CrossRef]
60. Krueger, R.A. *Developing Questions for Focus Groups*; Focus Group Kit; SAGE Publications, Inc.: Thousand Oaks, CA, USA, 1998.
61. Vargas-Hernández, J.G.; Vargas-González, O.C. Strategies for Meaningful Learning in Higher Education. *J. Res. Instr.* **2022**, *2*, 47–64. [CrossRef]

62. Al-Yafaei, Y.; Mudhsh, B. A Review Study on the Impact of Online Collaborative Learning on EFL Students' Writing Skills. *Int. J. Linguist. Stud.* **2023**, *3*, 8–18. [CrossRef]
63. Vega-Abarzua, J.; Pastene-Fuentes, J.; Pastene-Fuentes, C.; Ortega-Jiménez, C.; Castillo-Rodríguez, T. Collaborative Learning and Classroom Engagement: A Pedagogical Experience in an EFL Chilean Context. *Engl. Lang. Teach. Educ. J.* **2022**, *5*, 60–74. [CrossRef]
64. Alahdal, A.; Al-Ahdal, A.A.M.H. Effectiveness of Collaborative Learning as a Strategy in the Teaching of EFL. *Opción* **2019**, *35*, 1026–1043.
65. Kharroubi, S.; ElMediouni, A. Conceptual Review: Cultivating Learner Autonomy Through Self-Directed Learning & Self-Regulated Learning: A Socio-Constructivist Exploration. *Int. J. Lang. Lit. Stud.* **2024**, *6*, 276–296. [CrossRef]
66. Jiang, J.; Fryer, L.K. The Effect of Virtual Reality Learning on Students' Motivation: A Scoping Review. *Comput. Assist. Learn.* **2024**, *40*, 360–373. [CrossRef]