Web-Portal-Based Repurposing of VR Scenarios for TEFL Applications

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ABSTRACT
While there has been a dramatic uptick in the availability of VR games and scenario-based activities, there is a concurrent dearth of specialized content for relatively niche areas such as TEFL (teaching English as a foreign language). This paper explores the repurposing of existing VR content to meet the needs of TEFL-centric learning plans. Using a specialized web portal overlaying an off-the shelf scenario developed for HMDs, content can be added and experiences more tightly controlled, creating improved interactions and learning outcomes for students in certain skill brackets. In an interdisciplinary manner, this research tackles questions from both the VR and TEFL fields, while also tapping into a pressing issue from disability studies.

CCS Concepts
• **Human-centered computing→User studies** • **Human-centered computing→Virtual reality** • **Human-centered computing→Web-based interaction.**

Keywords
VR; TEFL; HMD; Web Portal

1. INTRODUCTION
The use of HMDs and VR-optimized applications has undergone a revolution in the past few years, in part fueled by the increased adoption of gaming-centric HMD systems. The educational field has also seen many use cases for these systems, from teaching product assembly to visualizing chemical processes. However, such abundance has not yet extended to virtual scenarios focusing on teaching English as a foreign language [1].

While many ESL (English as a second language) teachers are receptive of more widespread HMD implementation in the classroom, there are not many learning-specific offerings. Out of over 3,624 VR-exclusive games on Valve Corporation's Steam (As of December 8, 2019), one of the largest marketplaces for VR, fewer than five applications are specifically focused on English teaching, and only one is exclusively targeting TEFL (English Teaching Assistant VR by Infusion Entertainment, which is a platform to interact with a chatbot).

The low ratio persists on Facebook's Oculus Store, another large market, and no TEFL experiences could be found within the PlayStation VR Store by Sony, which is the current leader in headsets sold by number [2].

Thus, within this niche, content integrating the latest educational trends and with a variety of experiences is lacking, though some useful examples exist for other languages [3,4] and for situations where the student uses an ordinary (non-VR) desktop and display to experience a game-based scenario [5, 6].

Furthermore, these applications are often very limited in scope, one being the same experience for 30-plus languages. Given the massive availability and wide variety of game-based scenarios, this research posits that a system can be created to "repurpose" various VR experiences for TEFL education, particularly as "theme-based" and "task-based" teaching methods have increased in adoption [7], and their effectiveness has been supported. One experiment has even led to the development of a VR app for TEFL [8], though development can require specialized skills less

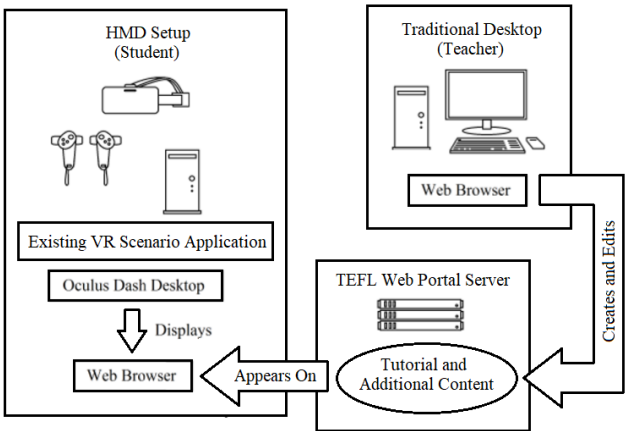

Figure 1. Repurposing System Diagram

common among TEFL instructors. Thus, this research focuses on integrating these TEFL concepts within a non-TEFL VR application. This particular experiment is tailored to a classroom lesson based on a chapter of the *Impact Issues* TEFL textbook, which focuses on the lives of disabled people.

2. SYSTEM OVERVIEW
Fig. 1 above is a diagram of such a repurposing system, which is divided in three major sections. On the top-right side is the teacher's setup. Using an ordinary desktop PC connected to the internet, the teacher can plan and create content to supplement an off-the-shelf VR scenario. This includes accessing a web browser.

On the bottom-right is the Web Portal server, a third-party server that hosts the Web Portal. As the teacher adds content to Web Portal pages, it is uploaded to the server with a click of the button. The content is then accessible by the student's PC setup.

On the left-hand side is the student's PC setup. The student wears an HMD (Oculus Rift CV1) connected to a portable, high-performance PC (HP Omen with an Nvidia GTX 1070 graphics card). The PC is running and displaying an off-the shelf VR scenario application. Concurrently, it is also running and displaying the Web Portal.

The VR scenario used for this experiment, "Experience: Colorblindness", is an HMD-specific application created by developer *iNFINITE Production.* It was made to emulate the lack of ordinary color vision someone color-blind may have, and users may attempt to tell citrus fruits apart while color-blind. The student is placed within a virtual grocery store and faces an empty shelf. Suddenly, the environment's colors become muted as a "deuteranopia" filter is applied. This filter simulates red-green color-blindness. The change in color, as well as the task layout, can be seen in Fig. 2 below.

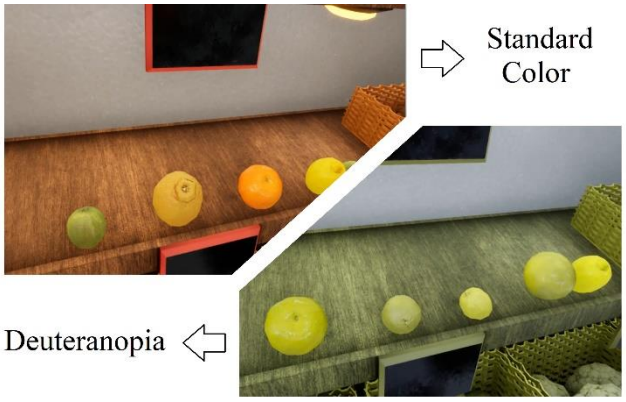

Figure 2. Layout of "Experience: Colorblindness"

As a recorded voice introduces the activity, a row of various types of citrus fruits appears on the shelf. Following audio and text prompting of fruit names, the user must choose the correct fruits matching the spoken and written names. For example, the student hears the voice say "tangerine" and chooses the tangerine on the shelf, ignoring the other, different fruits. In making this choice, the student uses the Oculus Touch controllers to navigate his or her virtual hands to the fruit of choice, and the student holds a button to grab it. The student moves the fruit over to a waiting grocery basket and releases the button, the fruit falling into the basket. Finally, a score is calculated, a ratio of correct to incorrect fruit choices.

The second major part of the system is the Web Portal, which is composed of three pages. The first is an introduction page explaining the purpose for the experiment and a set of instructions to deal with its contents. The second is a preparation page, a portion shown in Fig. 3, on the opposite column, that contains learning materials to teach the English words and pronunciations for the various fruits and help the students complete the tutorial. This may aid in a kind of vocabulary recall similar to that found in previous methods [9]. As seen in the left and right screenshots composing Fig. 3 on the opposite page, which are separated by one second, the photographs of the fruit are animated. The fruits shift from their standard colors to how they would look with some level of color-blindness. In addition, recorded pronunciations of the fruit names are listenable by clicking the "speaker" icon near each fruit. This might be an example of transformative content representation [10], alongside the fruit-picking activity itself.

Finally, on the third page, a short review activity allows Web Portal users to match the animated fruit pictures to the vocabulary. This third page uses an embedded Google Forms survey to automatically send the results for the teacher to evaluate by

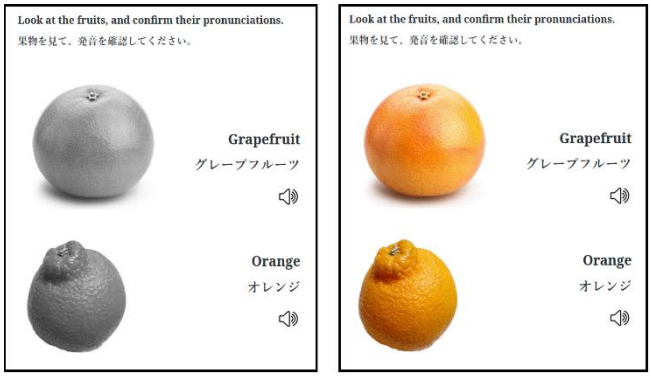

Figure 3. Color Change of Web Portal Example Page

checking his/her Google Forms account. This way, the students can complete a testing activity without removing the HMD. This testing format was previously evaluated highly by students [11].

The template for the pages on this portal was designed specifically for ease-of-use with VR headsets and controllers. The portal runs on the Chrome web browser and is inserted into the VR scenario through the Oculus Dash software. This allows for the portal to be accessible directly within "Experience: Colorblindness." Fig. 4 below illustrates how the portal can be used within the VR scenario. It is a floating "picture-in-picture" that can be manipulated with the movement of the Oculus Touch controllers. Pressing a single button on a Touch controller allows for clicking and scrolling as well. As the picture-in-picture is fixed to the standing position of the in-world position of the user, it follows the user around as the user takes steps in the scenario. In addition, the picture-in-picture is not tied to head movement, so it is

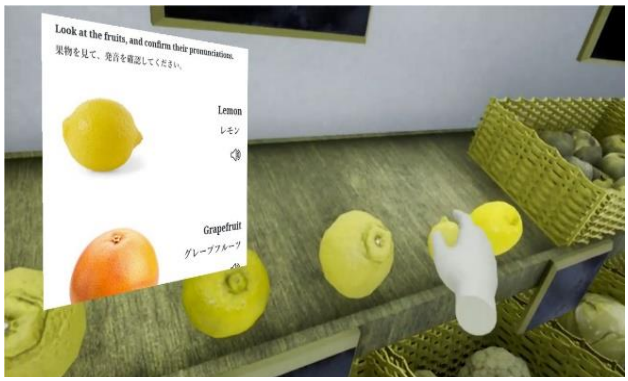

Figure 4. Web Portal Overlaying the VR Scenario

possible to move one's head to focus on the Web Portal and move it again to focus on the task at hand in the VR scenario.

The design considerations for the VR use case include large text that is readable even on the HMD screen, as well as simple, high

contrast backgrounds. Links and buttons are also oversized for easy navigation by the pointing-based HMD controllers. Multimedia features are also included, as mentioned earlier and emphasized in other research [12], which takes advantage of the

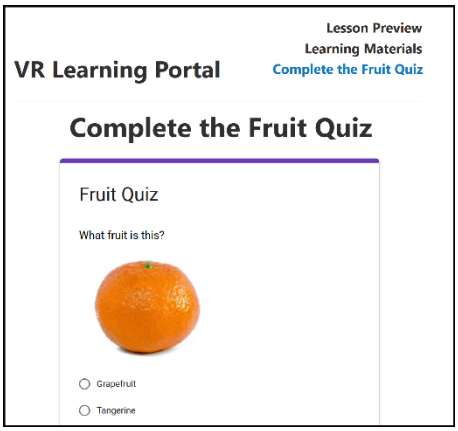

Figure 5. Web Portal Embedded Quiz

web-based format, and even the page with the embedded Google Forms test is designed to allow for maximum readability and usability with magnification, as seen in Figure 5 above.

3. RESEARCH QUESTIONS AND METHODOLOGIES

This research aims to evaluate the effectiveness of the Web Portal in repurposing a VR experience for TEFL activities. To that end, the first main research question is the effect on learning outcomes. The second is whether the Web Portal system is adopted without difficulty by students.

Finally, one of the major academic arguments about disability studies has to do with criticism that these studies paint the lives of disabled people as unthinkably difficult or impossible, leading to an increased sense of separation felt by non-disabled people towards disabled people [13]. This test hopes assert that tests and activities can be customized to avoid such an effect. Thus, the questions include if respondents believe the lives of color-blind people to be impossible or very difficult, and they also explicitly request coping methods.

To answer these questions, three main data sources are used. The first set includes an in-game score that measures the number of correct fruit choices and the number of incorrect fruit choices. For example, when a "lemon" is requested and the student places a lemon in the basket, the answer is marked by the application as correct. While this metric can take into account a number of skills, such as shape recognition and listening comprehension, we are focusing on the latter, which is emphasized in the interview questions. This data is not generalizable and not meant to stand alone, as separating the elements responsible for the choice outcome (shape recognition skills, listening comprehension, etc.) is difficult).

The results of the second test, the built-in Google Forms exam on the Web Portal, is used only to evaluate if the testing system is functional, and not as some sort of comparison between the TEFL-repurposed VR scenario and the original VR scenario.

The second data source is an eight-question multiple-choice survey on the user experience, web portal interface (if used), perceived effect on English-language education, and thoughts about the lives of the color-blind. The list of questions can be found in Table 1. Students responded on a five-point Likert scale. However, some of the questions did not follow the "positive to negative" spectrum as shown in Fig. 7 and Fig. 8. The five points for each question are not listed.

Table 1. Survey Questions

No.	Question
1	As a whole, please rate the ease of use for this experience.
2	Did you feel like you learned about how people who are colorblind might experience a daily situation like choosing fruit?
3	How was your experience with the web portal interface for reading text?
4	How was your experience with the general quality for listening to audio?
5	How was your experience with the web portal interface generally?
6	How do you feel about the English learning benefit of the stock tutorial/web portal at the beginning of the experiment?
7	How much do you feel the stock tutorial/web portal prepared you for the experiment?
8	Would you recommend this experience to someone?

The third source is a set of semi-structured interviews [14], one for each participant, revolving around potential experiment improvements and strengths and weaknesses. These open-ended questions allow for a more in-depth usability study. The seed questions for the semi-structured interview are in Table 2 below.

Table 2. Semi-Structured Interview Questions

No.	Question
1	Was there anything you liked about this experiment?
2	Was there anything you disliked about this experiment?
3	Based on his experiment, how do you feel about the difficulty of life when color-blind?
4	Do you feel this experience helped improve your English?
5	Without being able to see the full color spectrum, how did you choose the fruits?
6	How do you feel about theme-based English lessons, following social issues and such?
7	How could this experiment be improved?

The study group was composed of 10 vocational college students of various nationalities, aged 18 through 24, as well as six Japanese corporate employees, aged 24 to 38. The experiments were conducted in various locations in Tokyo, including classrooms and office meeting rooms. Eight of the students were considered "advanced" and eight of them considered "beginner" by a CEFR checking activity conducted as part of a separate teaching evaluation. "CEFR" stands for "Common European Framework for Reference of Languages", an international guideline by the Council of Europe for establishing levels of language learning achievements. For the purposes of this

experiment, “advanced” is considered CEFR B2 or higher in a majority of skill areas, and “beginner” is considered CEFR A2 or lower in the same. Half of each group underwent the experiment with the stock tutorial and half with the Web Portal.

Each experiment was done during an ordinary class and in an ordinary class environment, and students were briefed on the purpose of the experiment. No time limits were set for either the stock experience or using the Web Portal, but nearly all students finished in ten minutes or less. In addition, the experiment was entirely voluntary.

For the experiment setup, the environment was a 1.5 x 1.5 meter open space at the front of the classroom or meeting room, with the Oculus trackers placed on desks facing the user.

Figure 6. System in the Classroom Environment

As seen in Fig. 6, the user would stand in that open space and be able to take a step or two in any direction. The teacher would monitor the student visually for safety and provide guidance on using the HMD system, as well as rectifying any issues with running the experiment. In addition, the relatively small footprint and portability makes it relatively simple to set up. Setup times run from ten to fifteen minutes.

4. EXPERIMENT RESULTS

4.1 Survey

According to the survey outcomes, the advanced cohort had no real difference in results whether they used the Web Portal or not. The Web Portal interface itself was met with a positive reaction with the advanced group, and there were few to no difficulties with text size and general ease of use. However, there were some lower ratings concerning audio quality. This may be due to the occasionally noisy classroom environment. Upon further questioning after the experiment, a consensus formed that the stock tutorial was more than adequate to explain the experiment content, especially as most of the students were already familiar with the fruit names. More detailed results are found in Fig. 7.

However, there was a marked difference with the lower-skill group, and this is where the main interest of this research lies. The beginner students did not feel engaged with the stock experience’s tutorial and main content, and many of them were confused with the vocabulary and experiment flow. That is, of course, no fault of the application, as its design did not take into account TEFL considerations for beginner-level language learners. Holistically, many students did not feel prepared for the experiment with the existing tutorial. Attention should be directed towards the difference in effectiveness with the web portal versus no web portal for Question 1, Question 6, and Question 7. A very large jump was seen in Questions 6 and 7, and the reasoning behind this was made apparent in the semi-structured interview. More detailed results are shown in Fig. 8.

In this sense, the Web Portal shows that it is possible to tailor an existing lesson or scenario to be enjoyed by a wide variety of students, even if it is not necessary for all levels. Finally, the opinions concerning the ease of use, and text were also quite positive for the Web Portal with the beginners as well, though there may of course be the influence of the role of chance [15].

As mentioned he survey results can be seen at the bottom of this page:

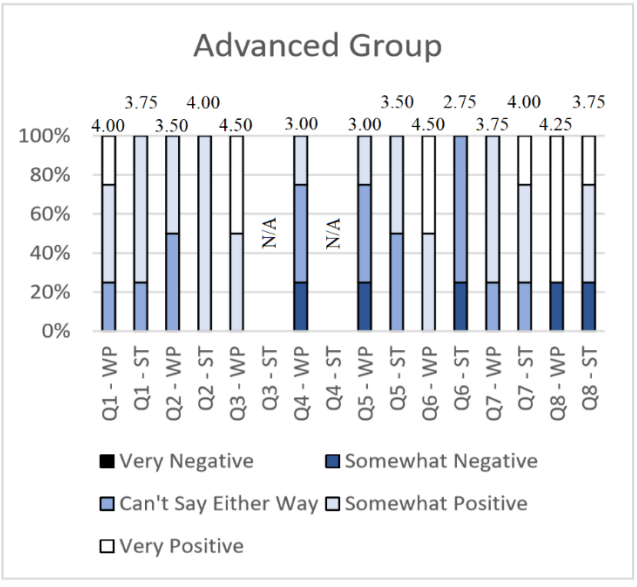

Figure 7. Advanced Student Survey Results for Web Portal (WP) and Stock Tutorial (ST)

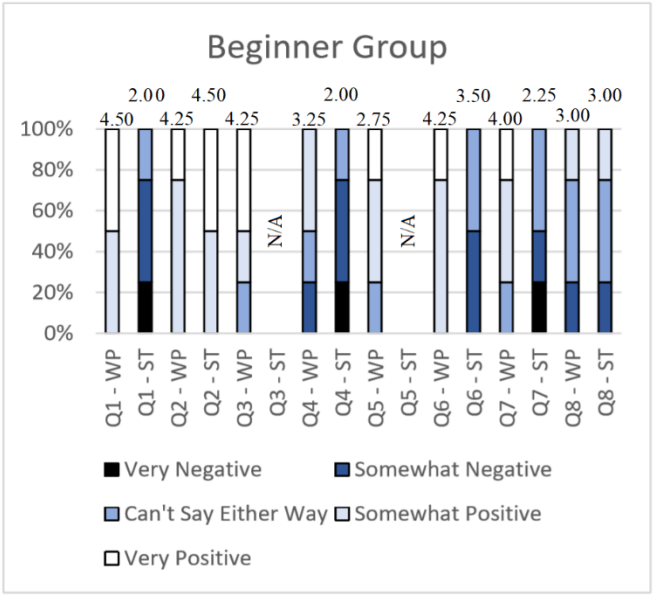

Figure 8. Beginner Student Survey Results for Web Portal (WP) and Stock Tutorial (ST)

4.2 Use Case Study

The semi-structured interview comments mirror the survey results on some metrics. There was no real difference whether the Web Portal was used or not for the higher-level learners, as they were already familiar with fruit names, though they did give positive comments on the Web Portal visuals. There was also no discernable difference between the responses given by business learners and the vocational school learners either, regardless of level.

However, here were many comments by both cohorts on the difficulty of some of the words found in the experience. While the application offers a stock tutorial that explains some of the concepts to an extent, the large number of students necessitated a streamlined approach to these subjects. Words like "deuteranopia" are uncommon for even native speakers, and words like "tangerine" and "grapefruit" can be confusing as well due to cultural differences and the use of "grape", respectively.

The motivation of students, an important area to test for [16], also seemed to be high, and it increased dramatically for beginner users of the web portal compared to beginner users with the stock tutorial. Many students commented on the game-based nature being a major motivating factor for learning, supporting existing research [17].

As for the lesson theme, the lives of differently abled persons, the survey indicates that this Web Portal provides a relatively positive view of life with a disability. This is unlike many disability studies that suffer from the effect of distancing or "othering" disabled people, particularly through providing an exaggerated level of difficulty. The Web Portal tutorial included an explanation and disclaimer about the experience, stating that the users do not have a lifetime or a long period of experience to deal with the effects. In contrast, people with born disabilities can draw from a lifetime of experience to cope. The Web Portal users, both in the advanced and beginner groups, felt that they learned more about how color-blind people deal with daily life. However, even this sort of appreciation and increased level of understanding is not without controversy itself [18].

4.3 In-App Data

As for the number of correct or incorrect fruit choices, there was little difference between the users of the stock tutorial and the users of the expanded tutorial / TEFL page when it came to the advanced group. However, there was a marked improvement in the results for the beginner group. This indicates that the Web Portal may provide a boost in comprehending the task at hand, and it may help with concept retention [19]. Incidentally, the Google Forms survey had successful results, with both level groups scoring over 70% correct, though only the Web Portal users had the opportunity to take it. For the In-App scores, see Table 3 below.

Table 3. Identification scores of participants.

Student Cohort	ID Score (Tutorial)	ID Score (No Tutorial)
Beginner (CEFR-B)	71%	38%
Advanced (CEFR-A)	73%	81%

4.4 Areas for Improvement

The small sample size of this experiment was necessitated by the in-depth analysis and classroom time constraints, though a larger cohort would have made the survey results more generalizable. However, the brunt of the results come from the use-case analysis. The second issue is the ability for only one student at a time to use the system. While the experiments themselves were run, the other students could not see what was happening. This was for purposes of not allowing early access to the content, which may unduly influence the results. For the last experiment session, however, the student audience was given an opportunity to watch a mirror of the VR headset content.

5. RELATED AND FUTURE WORK

This experiment is one of the first steps in the development of a systematic method to repurpose existing scenarios for TEFL settings. An earlier experiment using a VR-compatible and avatar-based social application, VRChat, as a platform for scenario-based language learning, showed that measurable learning gains are possible with this repurposing, and that students found it engaging, relevant, and recommended it highly to others. In the future, an extension of this Web-Portal-augmented experiment will be used in the longer term, perhaps a 3-month or 6-month study, to evaluate the role of the novelty effect and the ability of class management software to allow teachers and students to approximate many of the functions often necessitated in a traditional classroom (attendance tracking, testing, the use of individual education plans, etc.). This fits in well with collaborative virtual environments [20].

Integrating a single-student or small-group VR session into a larger classroom may also prove fruitful. During the final experimental sessions where the mirrored HMD screen was visible to the class, there was a lot of engagement and interest from the audience of students.

Finally, while the relative ease-of-use for teachers has been proposed in this paper, more concrete study is required, and considering how it, and VR in general, fits into overall reforms of college education is another fruitful area [21].

6. CONCLUSION

For the field of VR development, this experiment shows that it is possible to repurpose existing scenarios instead of requiring a large time and/or cost commitment for the development of a specialized application. App development, depending on complexity, can reach into the thousands of man-hours and cost tens of thousands of dollars. Setting that aside, the learning curve for a Web-Portal-based system is also relatively shallow. Many teachers have been given training on websites, and many school IT departments are equipped to handle questions at that level.

As for the educational field, these results show that not only customizing an existing turn-key content for a new educational purpose is possible, it can lead to increased learning outcomes for target groups of students, though not necessarily all groups. Students welcome these integrations into the classroom, expressing it through high levels of interest and engagement.

Expanding on the VR development side, this system supports that teachers without programming experience can still create content customized for their classrooms and learning goals, which may fill teacher needs as earlier explored [22].

Finally, for disability studies, it may show that it is possible to specifically design experiments that do not overexaggerate the difficulty of living with a disability, so that students can experience an approximation of the difficulties faced by disabled persons while not "othering" them.

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