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Toward a Method of using Virtual Reality for Skills Assessment in EFL

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The purpose of this paper is to make tangible a method of using virtual reality in the EFL / ESL classroom. The problems that are associated with the acceptance of using virtual reality go beyond just the price and the weight of a device used. Simply there are numerous types of applications that would not work well for classroom use as they create more instances of cybersickness due to sensory input conflicts which seem unnatural to the virtual reality user. A teacher must bear in mind applications that maintain a human-like field of view, lower rates of sensory mismatch such as not using fast-paced applications while a student is standing still, and as human as possible intuitiveness of interaction parallel to the natural control of navigation. Finally, a method for virtual reality assessment will be discussed as an example for an educator to begin to create their own experience in an effort to promote the positive transfer of skills and assessment out of virtual reality.

Keywords: Virtual Reality, ESL, EFL, Method, Classrooms, Skills Assessment, Positive Transfer

When language educators talk about using virtual reality for enhancing the classroom experience or even adopting virtual reality as the classroom experience, they get excited and want to use it but also have trepidation towards it for some very good reasons. While virtual reality has been around for a while, it has not had a systematic assessment on the effects of VR training on learning except in the medical fields at the beginning of the 2000s (Haque & Srinivasan, 2006). The early 2000s were before the advent of the newer, commercially available options in the late 2000s.

Regardless of this gap in the assessment of virtual reality on learning outcomes, it has been adopted in multiple fields outside of medicine and has been considered successful. Immersive virtual reality (IVR) has been commonly applied in the fields of engineering, aviation, design, mechanics, robotics, and industrial safety (Buiu & Gânsari, 2014; Wei et al., 2013). In a meta-analysis of thirty-one studies conducted in OECD countries, mainly the United States, United Kingdom, and Canada, it was found that of the ninety-one experiments virtual reality is on average more effective than traditional training as a way to develop student's technical, practical, and socio-emotional skills (Angel-Urdinola et al., 2021). Furthermore, the analysis results showed that for each additional hour of virtual reality training, students score 3 percent higher in technical (cognitive) learning assessments that

are given the same content instruction through traditional methods. The analysis also indicates that students exposed to virtual reality instruction receive on average 30 percent higher scores in socio-emotional skills assessments after training above other students with traditional instruction (Angel-Urdinola et al., 2021).

Virtual Reality: A user's price of Admission

For all of immersive virtual reality's good points in the above fields, it has its drawbacks which often are not cited in larger research projects. These problems can be a hefty toll to pay if teachers and students want access to a virtual reality experience.

For true immersive virtual reality, you need a commercial headset and controllers. The cheapest of these and most popular is Meta Quest 2. Depending on its availability, the usual price tag is around three hundred to four hundred dollars. As of mid-2022, it was announced that the price will be raised by at least 100 dollars by the Meta parent company, Facebook. VR Headsets are not cheap, not all students and teachers can afford them. A university would rightly be hesitant to purchase dozens of headsets not knowing the future value of the investment in learning for its students and faculty.

If the price was not an important variable, then the other major concern for virtual reality use in education is the feeling of cybersickness. Cybersickness, according to Stanny et al. (1997), is one of the many versions of discomfort that virtual reality users can experience. It is most often experienced as a kind of vertigo, a visually induced form of motion sickness from immersion in virtual worlds. It is caused by conflicting sensory information, and more than half of first-time headset users experience cybersickness within 10 minutes of being exposed to virtual reality (Cramer, 2022).

Many EdTech-experienced teachers in EFL worldwide and Japan have attempted to adopt virtual reality into their classrooms only to have found that this problem is a large hurdle to jump, with students outright refusing to continue virtual reality use.

Solving the Sensory Mismatch problem for Virtual Reality

If students are getting sick within the first ten minutes of virtual reality use and deciding that they cannot continue and refuse to try again, this is a major concern for educators willing to adapt VR to their classrooms. Thus, when students are in a virtual reality environment, there must be a congruence between the information they are taking in from VR, and that which is expected based on experience or what is expected by the student's sensory channels.

There are two main variables to be considered for reducing or eliminating cybersickness in virtual reality:

Display factors: Research shows that frame rates and field of view are the two main

proponents that influence immersion and cybersickness. The frame rate or frames per second is the term for the speed at which a program updates the changing frames on the screen of a game or application. In most instances, a frame rate of 60 to 90 fps for virtual reality games or simulations creates enough smooth motion to trick the sensory channels. Frame rates below the minimum of 30 fps often produce choppiness in frame refreshments on the screen creating a type of "flip book" effect in the game or application, which causes motion sickness in simulated environments (Jones et al., 2004).

Vection: Vection occurs in sensory conflict conditions and is the illusion of motion in the absence of true physical motion. Vection in VR strongly correlates to immersion. For the VR user to experience the illusion of self-motion, their sensory-motor control system must be convinced that their visual motion coincides with their body motion (Prothero, 1995; Chertoff and Schatz, 2014). As one may guess, if the expected and perceived motion does not coincide, then a user may feel nausea (Reason and Brand, 1975; Lin et al., 2002).

The sensory mismatch correlation was investigated by (Weech et al., 2019) in a literature study on immersion and cybersickness. They reviewed the research on the two factors and found that there is a negative correlation between them which is driven by sensory integration processes. Their conclusion supports the idea that immersion and cybersickness are inversely related and that the connection is mediated by the aforementioned factors of display factors, vection, as well as navigation control in VR (Weech et al., 2019).

In the same exhaustive review, they had also determined based on evidence obtained that the relationship between immersion and cybersickness in virtual reality can be adjusted for or offset by other factors to help diminish or completely negate cybersickness:

- Approaches to virtual reality use that reduce sensory mismatches show potential for reducing cybersickness and increasing immersion (Weech et al., 2019).

- Both immersion and cybersickness are increased by the addition of stereoscopy, high field of view display conditions, and by enhancing the likelihood that display will evoke vection (Weech et al., 2019).

- Increasing factors such as intuitiveness of interaction and control of navigation lead to higher presence and lower cybersickness (Weech et al., 2019).

- Men and individuals with more gaming experience demonstrate lower cybersickness and higher immersion. Although the partial effects of gender and gaming are not completely clear (Weech et al., 2019).

Taking these factors into consideration EFL teachers when implementing a plan to use virtual reality in the classroom, would be looking for virtual reality experiences that first can run at 60 to 90 frames per second with a normal human-like field of view (not a high field of view like many flat screen games). Second, educators would want experiences or

games that reduce sensory mismatches. If vection is a mismatch between the motion taken in from visuals and the perception on the body, then experiences such as race driving and flying would be far more susceptible since the body would not accurately be feeling what racing or flying is like, considering most have the experience of both. This may be offset slightly by sitting during a VR session, but it is also in the writer's personal experience not the case.

Lastly, virtual reality applications with the intuitiveness of interaction and control of navigation are important for lowering cybersickness. This means finding games or experiences that are closer to a more natural everyday way of interacting. Simulations such as mountain climbing or canoeing, use normal everyday interactions even if the experience is not an everyday one. The vection of such experiences is far more within everyday life while still being able to interact in a natural way while the user is able to see their own virtual bodies, creating intuitiveness in the interactions and control of their own navigation.

Examples of virtual reality games good for EFL

The following are examples that check off the variables for lowering cybersickness if adapted to EFL classrooms. These games run at higher frame rates, have a normal field of view and reduce sensory mismatch as they do not involve fast-moving vehicles or control of anything besides a virtual body. Because these games use human-like avatars in the virtual experience, the intuitiveness and navigation are also easy to adapt to.

- Job Simulator

In a world where robots have replaced all human jobs, step into the "Job Simulator" to learn what it was like 'to job'. Players can relive the glory days of work by simulating the ins and outs of being a gourmet chef, an office worker, a convenience store clerk, and more (Job Simulator on Meta Quest, 2019).

- Vacation Simulator

By the same company as "Job Simulator", a future in which robots do all the jobs and now the same human from Job Simulator is simulating various types of vacation.

- Cooking Simulator VR

It's a lifelike cooking experience! All the ingredients respond to your actions by changing temperature, appearance, and taste. Every time you're slicing potatoes, flipping steaks, or boiling a soup, there is some real-life physics applied to it. Each product has a different resistance to the knife, and you can feel it through haptic feedback of your VR controllers (Cooking Simulator VR on Meta Quest, 2022).

- Bartender VR

Working in four unique and professionally equipped virtual bars, you will experience the thrill of the art of bartending under the watchful eye of Tomasz Małek, a six-time Bartending World Champion. Begin your journey in a music club and learn how to make

four basic drinks. Prove yourself and win the opportunity to train and work in the next location. Master more and more demanding drinks as you progress to new, unique bars (Bartender VR Simulator on Meta Quest, 2018).

- Car Mechanic Simulator

Become a true master of the craft in this virtual reality simulation game. As a professional mechanic, your skills will be tested as you strive to meet your client's expectations. Immerse yourself in realistic gameplay as you prove your skills with the many available tools and car parts. Diagnose, repair, paint, and renovate highly detailed cars in your very own auto shop (Car Mechanic Simulator on Meta Quest, 2022).

- Real VR Fishing

Real VR Fishing is a relaxing fishing arcade with stunning graphics and scenery you can enjoy with your friends. Fish it your way! Experience static and relaxed float fishing or active lure fishing. Depth of water and the improved fishing mechanic is added to create more depth in gameplay!

(Real VR Fishing on Meta Quest, 2019)

- First Person Tennis

First Person Tennis is the first tennis simulator developed for VR. Now, you can play on a real tennis court and face professional tennis players. Show all your technical and tactical skills to climb the ranking (First Person Tennis - The Real Tennis Simulator on Meta Quest, 2022).

Besides these examples there are many other types of simulation games, but they are often more violent with guns and melee fighting. The other genre to be wary of would be the vehicle simulators as mainly experienced players or virtual reality users tend to play them as they have gotten acclimated to the vection and display factors that would give novice users cybersickness (Weech et al., 2019).

A Method for VR Assessment

An integral problem with implementing virtual reality in the classroom, aside from what was discussed, is assessment in the classroom. The point of using virtual reality to educate is to simulate environments, objects, and situations that could not easily or safely be demonstrated for learning without it. If virtual reality is to be considered an effective tool, then it has to have positive transfer from the virtual world to the real world with a method to determine the type of transfer.

An Example to work from

In a study on using virtual reality to improve table tennis skills, they investigated the skill transfer from virtual reality sports training to real-world table tennis. Fifty-seven

participants were assigned to either the VR training group or the no-training control group. During virtual reality sessions, players were immersed in table tennis matches against an artificial intelligence opponent. Both a quantitative and qualitative assessment was administered to the participants (Michalski et al., 2019).

A quantitative score was taken from participants performance on table tennis tasks. Scores were calculated on the number of successful returns (hitting the ball back to the opponent) in one of three skills taught in VR: backhand hits, forehand hits, and alternating hits (Changing hits continuously between fore and backhand). In addition, serving accuracy was assessed with a target game. Soft drink cans were lined up at the opposite edge of the table, as the best type of serve is one that gets the ball as close to the opponent's edge and bounces low off the table. A score was derived from how many soft drink cans could be knocked from the table, one at a time on a serve. For example, if ten cans were knocked down on ten serves that equated to one hundred percent (Michalski et al., 2019).

The qualitative assessment or as Michalski et al. (2019) put it, "quality of skills" assessment was based on the judgement of a professional table tennis player who observed each of the participants during the tasks. The professional evaluated the improvement in each participant's quality of skills in five categories: ball height, strength, consistency, technique, and coordination. The professional scored improvements in each of the categories using numerical values: 0 for no improvement, 1 for some improvement, and 2 for major improvement.

Both the quantitative and quality of skills assessments were considered independent of each other as they were evaluating different aspects of table tennis and it could be expected that participants might improve in one assessment but not in the other (Michalski et al., 2019).

Transfer of skills

In a lengthy review of virtual reality skill training applications by Xie et al. (2021) they discuss the common assessment tests and evaluation methods that are used to validate transfer of skills in virtual reality applications to real settings. Similar to Michalski et al. (2019) they describe quantitative and qualitative measures.

The most commonly used method is the quantitative method, a form in which a pre- and post-test design is used. Measurements are taken before and after treatment and are usually the same questions simply used for both measures. This enables the evaluation of any impact of training on the participant (Xie et al., 2021).

In virtual reality research, biometrics are often used for quantitative measures. Biometrics is defined as the use of distinctive, measurable, and physical characteristics to describe individuals (Xie et al., 2021) which is divided then into two groups: identifiers of the body, such as retina scans or fingerprints, and psychophysiological measures of human behavior and

psychological state (Jain et al., 2007). Examples of biometrics are:

Eye tracking - measures the fixation and duration of an individual's eye movement behavior (Bergstrom and Schall, 2014).

Facial Expression analysis - records facial muscle activities via electrodes in response to emotional expression (Yoo et al., 2017; McGhee et al., 2018).

Galvanic Skin Response (**GSR**) - Measures the variation of skin conductance caused by changes of sweat glands (Tarnowski et al., 2018).

Heart Rate Variability (**HRV**) - Measure of the variance of heart rate speed (Williams et al., 2015).

Eye Tracking, GSR, and HVR are the most used biometrics because of their ability to predict the affective state of the subject. Biometrics provide valuable information on the emotional state and attentive state of the user in real-time, without limitation of language or bias (Xie et al., 2021).

The other approach, more within reach of EFL teachers for transfer assessment is qualitative design.

Qualitative encompasses interpretivism, epistemological orientation, and constructionism as its primary driving forces (Bryman, 2006). In virtual reality research, it is used to understand a participant's experience with certain phenomena. This understanding is important to better support the transfer of training and the content of the training as it is detrimental to be as close to exact as possible in the areas or topics users need to learn (Xie et al., 2021). For the research by Michalski et al. (2019), the role of qualitative assessment was in the recruitment of a professional table tennis judge who adopted their own set of criteria for the transfer of skills (training).

Building your own virtual reality assessment for EFL classrooms

The assessment of objectives learned in virtual reality is undoubtedly a difficult hurdle for EFL teachers. Typically, commercial-grade VR headsets do not come equipped with biometric assessments, rather these are costly additions that are often only used for high-end serious research, or they are entirely different headsets altogether that are even more expensive.

To this end, something pragmatic like Michalski et al. (2019) had accomplished would function well in a classroom: the use of standard virtual reality equipment for the evaluation of an everyday sport. It would also be logical, following the example given, to go down the same route of separately evaluating the quantitative and qualitative virtual reality data from an EFL classroom.

An EFL teacher must then first choose the right application or game for what they

intend to explore in virtual reality that is applicable to their goals in the class. The initial step is evaluating said games or applications for the variables needed to keep cybersickness away, such as they are running at higher frame rates with a normal field of view and reducing sensory mismatch by making sure the applications use human-like avatars that reinforce the intuitiveness of interaction and control of navigation.

A well-known quantitative example would be pre-, and post-tests adapted for a VR game used in the classroom. Pre- and post-vocabulary tests could be used to determine any vocabulary gained from virtual reality. Survey data on pre- and post-virtual reality gameplay would be able to understand the experience of students using virtual reality.

The problematic part of assessment comes from the actual "skills" that are being tested. As educators typically do not have large budgets or time to create magnificent set pieces to mimic the virtual world (creating such pieces defeats the purpose of using VR to begin with), a simpler quick, and easy set of props would be efficient. Something that symbolizes the virtual world and objects that a student could readily understand and manipulate in a skill assessment. One such way is to make and print cutouts that can be used by students to show what they have learned in virtual reality. The following image example comes from a shared research project using a virtual reality game that teaches basic cooking. The video is made by the authors and can be accessed through
(https://www.youtube.com/watch?v=gevgaBZ1u6E&ab_channel=coffeeserpent).

Initially, the student was given the vocabulary pretest on the objects in the VR world and a survey on their feelings or ideas about VR in education. Next, the student was asked to play the game through the first section of levels teaching the basic skills needed to cook the items in the VR game. When it was finished, the student was asked in English to perform the tasks that were learned in virtual reality on top of a vocabulary post-test and exit survey. The instructor in a way parallel to Michalski et al. (2019) evaluated the student's performance of tasks and judged with a rubric using numerical values.

Figure 1. A student taking virtual reality skills assessment (Source: Authors)

Conclusion

The most logical and very well-known theory in education is that of Constructivism. The main push of the theory is that learners do not just passively sit back and take in information, rather they construct knowledge by taking in the new information and merging it with what they already know or understand. Like these are Vygotsky's Scaffolding and Krashen's Input Hypothesis. The similarity between them all and what is shared with the vaguely proposed method of using virtual reality is that a learner starts with a certain amount of knowledge to begin with, not an empty shell waiting to be filled. It is the purpose of virtual reality to act as the facilitator to add new information that will be blended with the old to create new ideas, skills, or ways of thinking. Thought of in this way, virtual reality becomes a constructivist learning tool.

As a tool of constructivism, virtual reality has two main benefits if EFL educators choose to adopt it in their own search for positive transfer. First Scaffolds are naturally embedded in virtual reality environments as the visual cues such as tooltips, text dialogue, or a glowing blinking outline are almost always in or close to the necessary object in VR space that students need to interact with. These scaffolds are temporary and can be removed through menus in the game when the student reaches their potential (Bacca-Acosta et al., 2021). Second, virtual reality has the advantage of automatic gamification, performance metrics, and collaborative interactions (if using multi-player applications) already in the software. This allows for constant peer interaction, active learning, enjoyment, and performance feedback - all elements that enhance proficiency-based learning (Angel-Urdinola et al., 2021).

Problematically it is less about convincing EFL teachers to adopt virtual reality as a tool, but how to solve the problems that arise from its use. Cybersickness being the most important barrier can be offset if an educator keeps in mind the type of application they want to use in the classroom and make sure it adheres to display factors, vection, and intuitive interactions that are something learners can easily adapt to rather than trying to go for the most spectacular fast-paced experience possible. In the need to assess skills learned in the second language through positive transfer, the assessment could be done with little more than a color printer, scissors, and the time it takes to cut carefully.

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