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# A Review of Virtual Reality and English for Academic Purposes:
## Understanding Where to Start

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## ABSTRACT

Virtual reality (VR) has garnered increasing attention as a pedagogical tool for language learning. Yet, despite the many affordances of using virtual reality learning environments (VRLEs), there remains a paucity of research investigating the use of VRLEs for English for academic purposes (EAP). While BALEAP '19 conference presentations related to VR were well attended, suggesting there is interest in VR and EAP, many practitioners and researchers may be hesitant to explore using VR for EAP due to difficulties in selecting suitable equipment, understanding VR related terminology, and selecting or creating appropriate VRLEs for their pedagogical and research purposes. The objective of this article is to reduce the difficulty of some of these initial obstacles by providing overviews of relevant literature, VR terminology, technology, and software, as well as providing examples of potential uses of VR for EAP and a framework for investigating VR in EAP pedagogy and research.

## KEYWORDS

Augmented Reality, EAP, English for Academic Purposes, English for Specific Purposes, ESP, Extended Reality, Virtual Reality, Virtual Reality Learning Environments

## INTRODUCTION

The availability of affordable, high-quality VR equipment has led to an increased interest in using VR technology for training and educational purposes. While there is growing interest in exploring VR as a pedagogical tool in second language acquisition (SLA), there remains a scarcity of research regarding how VR technology could be utilized for English for Specific Purposes (ESP) (Lin & Lan, 2015), including English for Academic Purposes (EAP).

Hoping to encourage language teachers and researchers to explore the possibilities of using Virtual Reality Learning Environments (VRLEs) as pedagogical tools in the field of EAP, the purpose of this article is to assist EAP practitioners and researchers who are interested in using VR for their own teaching and research contexts, but may be hesitant to spend the time and resources to explore these possible uses. First a review of relevant literature will be given. This will be followed by an

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overview of prominent VR terminology, technology, and software. After which examples of potential uses of VR for EAP will be discussed, and a framework for investigating VR in EAP pedagogy and research will be given.

## LITERATURE REVIEW

VR is a technology which possesses unique qualities, and therefore can afford unique benefits. Burdea and Coiffet's (2003) seminal book identified the three I's of VR technology, which are still widely used as the framework for studying VR today. These I's are Immersion, Interaction, and Imagination.

Immersion is the quality of feeling present in, and a part of, a virtual world. Blyth (2018) saw immersive virtual environments as a new frontier for experiential learning through creating increasingly authentic contexts for learners to engage with.

Interaction, the second characteristic of VR technology, can be understood in several ways. Interaction in VR environments can be very different from using a computer mouse or a touch screen smartphone because VR offers the ability to interact as one would in a real-world environment. Users of VR can walk around a virtual room with their feet and pick up virtual objects with their hands. But interaction can also be understood in terms of users engaging in real-time contact, communication, and collaboration with other users.

The third component of the framework is imagination, which Burdea and Coiffet (2003) define as the attribute of VR applications to solve real world problems. A VR application, if designed well, can evoke a user's imaginative and creative abilities to "perceive non-existent things" (Burdea & Coiffet, 2003 p.3). For example, a VR flight simulator can be used to see if a pilot in training is capable of landing a particular airplane on an aircraft carrier. In other words, as Dalgarno and Lee (2010) describe it, imagination is the capability of putting users in improbable or impossible scenarios, such as inside a human heart or the surface of Europa, where they can increase perceptual knowledge or discover new connections between ideas.

In research, VR technology has been found to be conducive to constructivist learning (Girvan & Savage, 2019), and the majority of studies on VR technology in language learning use the constructivist framework to focus on such things as interaction, transfer, and experiential learning (Wang, Lan, Tseng, Lin & Gupta, 2019; Lin & Lan, 2015). Researchers and practitioners have been using VR technologies in this context to better understand its uses and efficacy, however the focus in language learning has been focused more on task-based activities and general English, leaving academic uses of the technology yet unexplored.

While the question of how VR may best be applied in the realm of EAP is still being explored, a number of studies have investigated the leveraging of VR for more general aspects of language learning which could be adapted to EAP. In regards to the writing process, virtual worlds have been used as platforms for digital story telling (Xu, Park, & Baek, 2011) and investigative writing (Warren, Stein, Dondlinger & Barab, 2009); VR 360 degree videos have been used to provide context and information for academic writing assignments (Dolgunsöz, Yildirim, & Yildirim, 2018); and Google Earth VR has been used in expository writing (Chen, Smith, York, & Mayall, 2019). Speaking skills have also been a focus in research. Hassani, Nahvi and Ahmadi (2013) found the use of virtual environments to be effective in improving speaking and listening skills among English learners, and Niebuhr and Michalsky (2018) observed an improvement in public speaking and presentations skills when learners practiced in front of a virtual audience as opposed to practicing alone.

General pedagogical benefits of using VR include a reduction of anxiety and affective filters (Schwienhorst, 2002; Lin & Lan, 2015), the enabling of social interactivity and connectivity (Schwienhorst, 2012), increased motivation (Reinders & Wattana, 2014), and long-term retention of information (Dolgunsöz, Yildirim, & Yildirim, 2018). However, not all studies have yielded encouraging results. Wang (2017) encountered multiple technical difficulties in her study of using the social virtual world Second Life in an English course, citing unreliable functionality as well as hardware and connectivity issues. A recent study by Makransky, Terkildsen and Mayer (2019) found that immersive environments may actually reduce the learning that takes place and showed learners had a higher cognitive load compared to those who were not using an immersive virtual environment. Constraints such as these are not an uncommon issue in the realm of computer assisted language learning (see Reinders & Hubbard, 2013; and Beatty, 2010 pp. 159-183). Yet as with any emerging technology, as our understanding of it increases, so come solutions to the perceived difficulties and shortcomings. The remainder of this article therefore aims to increase EAP practitioners' and researchers' understanding of VR with the hope of encouraging further exploration in the leveraging of VR technologies for pedagogical and research purposes.

## VR TERMINOLOGY AND TECHNOLOGY

With terms like HMDs, haptics, refresh rates, presence, immersion, and degrees of freedom, it is easy to understand why some educators and researchers, although interested in VR, feel hesitant to utilize this technology. Learning some basic VR termonology may reduce some of the initial difficulty in getting started, such as what VR equipment should be purchased and whether an existing VRLE should be utilized or a new VRLE should be developed and tailored to one's needs. The following sections offer a brief overview of important VR terminology and technology.

### VR/AR/MR/XR

While "VR" is used commonly by the public as a blanket term for VR related technology, manufacturers, designers, researchers, and VR enthusiasts divide the world of VR into three main branches. VR stands for Virtual Reality and refers to when the user's vision is completely occluded by VR hardware by means of a head mounted display. Vision of the real world is completely replaced by a virtual environment. AR is short for Augmented Reality and refers to when the real world has a digital overlay. The user can see both the digital overlay and the real world behind it. An example would be the game Pokémon Go, where smartphone or tablet screens show characters overlaid on the players' real world settings and can be interacted with. MR stands for Mixed Reality and refers to when there is a digital overlay similar to augmented reality, but the digital layer interacts with objects in the real world. Lastly, the term XR stand for Extended Reality, and refers to any type (or all types) of artificial reality, including VR, AR, and MR.

### HMDs

An HMD, or head-mounted display, is a piece of hardware, such as a headset or pair of goggles that include small monitors in front of each eye, allowing the user to see images in three-dimensions. Some HMDs are tethered, meaning that there is a wire connecting the HMD to a computer, and without the computer the headset cannot be used. Other HMDs are stand-alone units that can be used by themselves and do not need to be tethered to a computer.

Besides differences in visual and ergonomic design, HMDs vary in quite a few ways: field of view, resolution, pixel density, sensors, refresh rates, how many degrees of freedom the HMD tracking system allows, weight, whether the HMD needs to be tethered to an external device or not, and of course price.

The number of brands and models available on the market further complicates the process of selecting the hardware that is most suitable to one's specific pedagogical or research context. Narrowing the field just to VR HMDs, major corporations such as Facebook owned Oculus, Valve, HTC, Sony, Samsung, and Lenovo produce a variety of models. While the primary focus of these corporations is VR for entertainment purposes, there are companies, such as Veative and Mondly, who design VR related hardware and software for educational purposes. Each HMD has its own advantages and disadvantages; it is impossible to say which one is "the best" as this depends on context and intention of use. In addition, the fact that existing models receive regular upgrades and completely new models are introduced nearly each year can make it difficult to stay current with the latest and greatest technology.

How HMDs can be used for language learning and research largely depends on the type of HMD utilized and the subsequent capabilities afforded by the hardware. In addition to the capability of tracking motion, some HMDs afford language teachers, learners and researchers with the abilities to record audio and video, to interact with other users via the Internet, and even to track the movement of the user's eyes. If an educator wanted to utilize 360 degree videos to provide context and information for writing assignments (e.g. Dolgunsöz, Yildirim, & Yildirim, 2018), then students' smart phones can serve as HMDs, given they have an easily affordable viewer such as Google Cardboard, Homido Mini, or Knox V2. If an EAP teacher wanted students to be able upload presentation slides to a VRLE and receive feedback on pace, hesitation markers, and eye contact, as well as be able to record and share their presentation, such VRLEs exist (e.g. Niebuhr & Michalsky, 2018), but this would require the HMD to have the hardware necessary to support these functions. If an educator wanted students to improve the coherence and cohesion of their writing by virtually painting sentences within a paragraph according to their functions (e.g. Pack, Barrett, Liang & Monteiro, 2020), then a more expensive and powerful HMD that tracks movement would be required. The following section describes the terminology used to describe HMD's ability to track motion.

## DoF

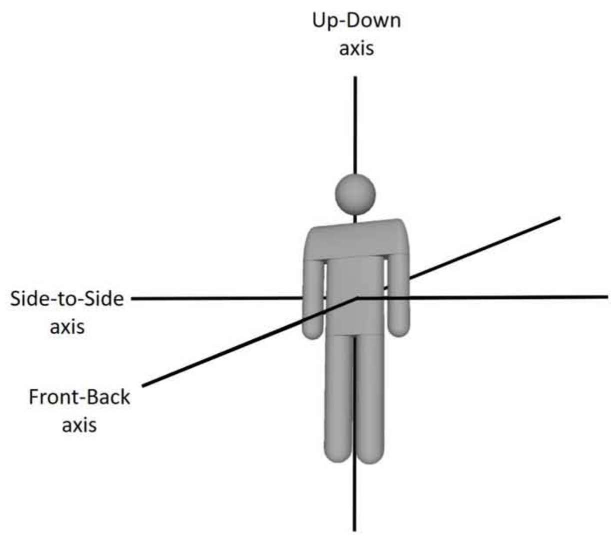
Different HMDs and controllers afford users with different degrees of freedom (DoF), or trackable movement. The higher-end products offer six degrees of freedom, or 6DoF. This means that the VR equipment, by means of cameras or sensors on the HMD, controllers, or nearby sensor towers, will track complete motion of the HMD and controllers (see Figure 1). Armed with 6DoF technology, the motions of the user in the real world are mirrored in the VR environment. If a user squats, the VR system will track the motion of the HMD and controllers. If the user moves forward, swings a non-existent bat, or walks forward, these motions are likewise reflected in the virtual world. In contrast to 6DoF technology, HMDs and controllers that only afford three degrees of freedom, or 3DoF, track a more limited range of movements. These movements include looking around or moving your wrist and hand in 360 degrees. Equipment with only 3DoF does not track motions made forward, backward, side to side, or up and down, and therefore come at a lower price tag.

## Presence and Immersion

One of the major advantages of using a VR HMD is the feeling of being present and immersed in a virtual world. Fully immersive VR is achieved, primarily, through the visual optics of the HMD, but can also be supported through aural, tactile, and locomotive interactivity. The affordance of immersion by HMDs allows for experiential learning to occur in virtual environments that mirrors real learning contexts as well as learning contexts not readily available to the language learner (Kwon, 2019). An example of such immersive and experiential learning could be an English for Medical Purposes student learning vocabulary related to the cardiovascular system by virtually traveling inside a human heart).

Presence is a related term, but distinct from immersion in that it describes the subjective sense of being in a particular place. The terms can be differentiated by understanding immersion to be brought about by the technical components of VR and presence as a psychological affordance (Dalgarno & Lee, 2010). The feeling of presence is not necessarily exclusive to VR as it can be achieved through interacting with 3D video games or even imaginatively while reading a captivating story; however, VR that employs HMDs is uniquely immersive in that it completely occludes the real world; this is known as fully-immersive VR. The psychological sensation of being in a different place is a key aspect of VR technology that brings unique pedagogical affordances. For example, there is some evidence which may suggest that students can feel more motivation, be free of peripheral distraction of the real

**Figure 1. The three axes of motion tracking afforded by 6DoF**




world, and more easily transfer learned skills to real life contexts (Grant, Huang, & Pasfield-Neofitou, 2013; Lan, Lyu and Chin, 2019; Dede, 2009).

## VR SOFTWARE

Understanding VR software is equally as important as understanding the basics of VR hardware. It is important to note that VR software (e.g. a VRLE) may not necessarily be supported by all VR hardware; some programs work on multiple VR hardware systems, while others may only work on one particular hardware system. There are three basic avenues an EAP practitioner or researcher can take when it comes to leveraging VR software: using existing free programs, using existing programs that need to be purchased, and creating their own program; each of these have their advantages and disadvantages.

In the authors' opinion, free programs tend to be less developed, contain more glitches, be less visually appealing, and offer less support than purchasable programs. The advantage, of course, is that they are free and the EAP practitioner or researcher can experiment with how the program can be adapted for their own purposes without having to commit any additional economic resources.

Programs that require a purchase tend to be better developed, contain less glitches, be more visually appealing, and offer more support. The disadvantage of using these programs is the amount of resources needed to be expended. While some programs require a one-time purchase, other programs require a monthly subscription fee. If multiple VR units are being used, then the cost of increasing the scale of use may quickly become problematic.

The primary advantage in creating a new VRLE is that it can be designed from the ground up to specifically address the pedagogical practice the EAP practitioner or researcher wants to explore. This option, however, is perhaps the most difficult as it requires more money, time, and expertise. If an EAP practitioner or researcher wants to pursue this route, working in collaboration with university computer science faculty and students or hiring a freelance software developer may be viable options.

The following section will select some existing VR software applications and describe their potential uses for EAP.

## LEVERAGING VR FOR EAP

One potential way of leveraging existing VR software applications is to teach vocabulary related to a specific academic discipline. The purchasable physics simulation program Universe Sandbox 2, for example, allows for users to explore the solar system, create their own solar system, and simulate a variety of physics related phenomena such as gravity, changes to Earth's climate due to changes in its tilt and distance from the sun, the evolution of stars into supernovas by manipulating age and mass, material interactions of planets made of different elements, and the dynamics of light as it interacts with black holes. A wide range of vocabulary could be taught that relates to just one of these phenomena - changes to Earth's climate: climate, planetary energy balance, infrared light, surface temperature, complex systems, albedo, albedo feedback, the greenhouse effect, atmosphere, global average temperature, equator, tilt, pole, global climate model, latitude and longitude, water vapor feedback, and greenhouse gases, to name a few.

Another example of a VR program that could be leveraged for teaching academic discipline-specific vocabulary is CalcFlow, a free VR software program that allows users to explore vector calculus in an immersive and interactive virtual environment. Through mathematical modeling and manipulating 3D graphs, users are able to edit parameters of equations and observe models that are rendered live. Potential vocabulary to be taught include functions, vectors, vector addition, coordinates, parameterized functions, single and double integrals, coordinates, sphere, radial wave, sine and cosine, amongst others.

An additional way of leveraging VR for EAP is for practicing the delivery of presentations. Several VR applications (e.g. Ovation and Virtual Speech) are available which allow users to practice public speaking or giving a presentation in a variety of settings from conference halls, to boardrooms, or classrooms; some programs allow for customized settings. Some of these programs can interface with Microsoft PowerPoint to input a user's slideshow and can also support other image, video, and audio content. Most importantly, they can provide detailed feedback to the user on features of speech such as fluency rate, grammatical accuracy, vocabulary usage, and depending on the VR device being used, can track the level of eye contact with the audience.

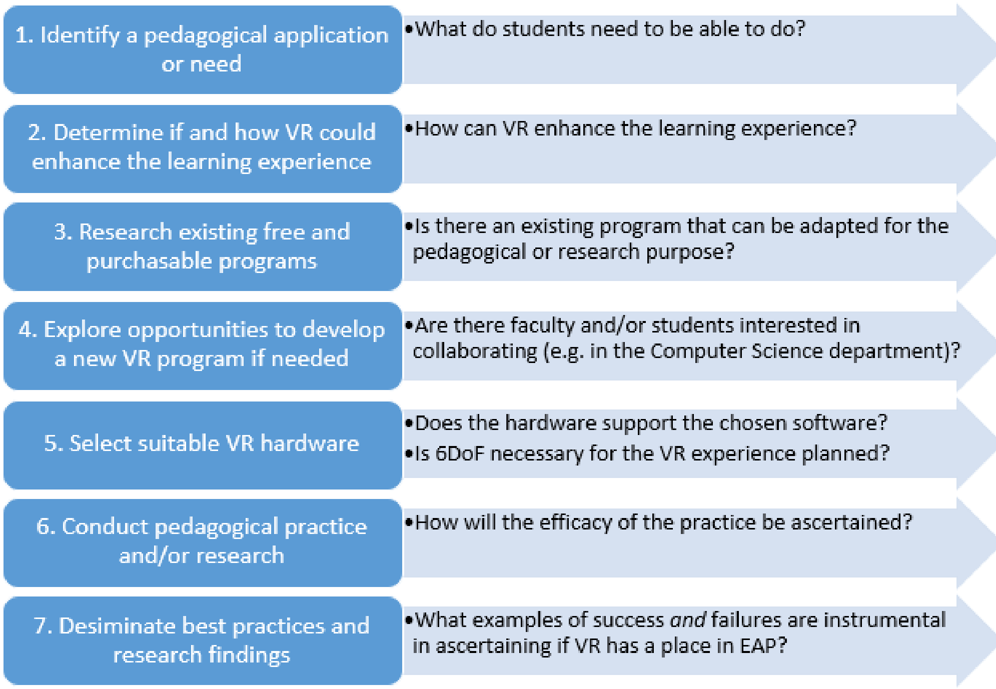
While many studies investigating how VR can be leveraged for improving writing tend to focus on the writing process, especially the pre-writing stage (e.g. Dolgunsöz, Yildirim, & Yildirim, 2018), Pack, Barrett, Liang & Monteiro (2020) created a VR application for explicitly teaching and learning paragraph writing structure. Their program presents users with paragraphs of varying structural complexity and has them read and then virtually paint each sentence in the paragraph according to its function. This is an example of how a VR program can be created for a specific EAP need.

The above examples are given to help the reader generate ideas of potential ways of leveraging VR for EAP. As both practice and research on leveraging VR for EAP is in many ways still in its infancy, and as many EAP practitioners and researchers who are interested in exploring the use of VR for EAP may not know where to start, the following framework (see Figure 2) is given as a possible way forward in ascertaining to what degree VR may be suitable for EAP related pedagogy and research. The framework has been developed by the authors based on their experience of both creating new VR programs and using existing VR programs for language pedagogy.

## CONCLUSION

While there has been a growing interest in the use of VR for language teaching and learning, the use of VR for EAP has lagged behind this trend. Despite the various challenges EAP practitioners and researchers are confronted with when leveraging VR for EAP (e.g. VR related jargon, purchasing

**Figure 2. Framework for investigating VR in EAP pedagogy and research**




suitable equipment, finding the right software), the unique benefits that VR affords merit further exploration. As VR for EAP is still mostly unexplored, it is the authors' hope that EAP practitioners and researchers who decide to get involved in the exploration of VR for EAP will share their experiences, their successes and their failures, with the larger EAP community. In doing so it will become easier to ascertain to what degree VR has a place in the field of EAP.

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