

Virtual Reality: A New Way of Teaching Scuba

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### Abstract

Technology advancements have changed the way people participate and engage with hobbies and activities around the world. Recreational scuba diving has seen major improvements over the last several decades with better manufactured equipment, improved training, and more awareness around the sport. Interactive training is a key component for students who are learning how to dive. A combination of video, multimedia, hands-on, and written materials are used today to certify students. Augmented reality (AR) and Virtual reality (VR) are emerging technologies that could potentially be powerful tools when teaching the sport of scuba. Similar to how pilots use flight simulators for training, students could use VR and 360 video content to become fully immersed in scuba diving scenarios that will help them in real-world diving situations. The focus of this literature review explores the role of interactive technology in teaching students and how scuba diving could leverage virtual reality and 360 videos. Three specific themes emerged when examining this research: digital tools for learning, learning theory and teaching styles, and future technologies.

*Keywords:* Online learning, distance education, apps, connectivism, education, modern teaching, digital learning, VR, augmented reality, future technology

## Introduction

Scuba diving is a growing recreational sport with millions of people learning how to dive every year around the world (Edney, 2016). When learning how to scuba dive, it is important to understand the major risks involved with breathing and navigating underwater. While it is normally a safe sport when all the proper training and safety precautions are taken, scuba can be dangerous, at times life-threatening. Most diving related accidents occur from lack of certain training and skills (Hatsushika, Nagata, & Hashimoto, 2019). Include a few examples of most prominent accidents directly related back to poor or lack in training/skills.

Diving scenarios can occur in a number of different ways depending on the environment. It is common to dive directly from a beach shore, off the side of a boat, or even in a local lake or rock quarry. Each diving situation requires a different mode of entry and environmental awareness before getting into the water. It is common for a local divemaster to provide or facilitate a pre-dive safety briefing to discuss potential hazards and situations to be aware of. These safety briefings also allow people to make sure they have all the necessary gear to complete the dive. Dive briefings also point out the exciting wildlife, historic shipwrecks, or important landmarks of that particular dive event. Because most beginner divers have never encountered these types of situations, technology could help prepare students for these particular scenarios. Increased diver awareness and preparation using better methodologies could overall improve the sport and save lives while scuba diving.

Digital training and education continue to grow and become more advanced as technology continues to progress. To improve training and skills needed to become a successful diver, future technologies must be considered when teaching the sport of scuba. Virtual reality (VR) is a technology that is currently not leveraged when training scuba divers. Today, scuba is

taught with a combination of video, multimedia, hands-on and written material. Students could use VR to prepare them for situations that cannot be taught with current training techniques.

When researching ways to improve the sport of scuba diving, it is important to understand digital tools for learning, learning theory and teaching styles, and future technologies.

### **History of Scuba Diving**

The general interest to explore the underwater world has been around for thousands of years. According to Dimmock (2007), the recreational sport scuba diving has grown in popularity due to the advances in scuba equipment, which has allowed for people to explore our underwater marine environments (as cited in Edney, 2016). People have been exploring the underwater worlds for thousands of years. The mystery that lies beneath the surface of the ocean and the wide range of wildlife one has the opportunity to see have captivated people for centuries and is often the focus of mainstream television movies and documentaries. Dimmock (2007) also referred to the importance of scuba diving to local economies and growing global travel and tourism (as cited in Seaman & Depper, 2019). Two topics that are important to divers are tourism and the value of the scuba diving experience. Research has shown that tourists are value driven, and when a diving experience is considered to enhance emotional and social values, people are likely to pay more for the experience (Schoeman, Van der Merwe, & Slabbert, 2016). Cameras and underwater equipment advances have also made the sport of diving easier to discover. Underwater photography and videography equipment are sold in most electronic stores. This equipment is also affordable for anyone to capture stunning photos and post them to social media. Cater (2008) mentioned how diver curiosity and experience gradually change as skills are refined and experience is gained (as cited in Edney, 2016). Some people are seeking the next big thrill. Scuba diving offers a unique experience that is certainly never the same.

Training to become scuba certified has evolved over the last few decades. Students must complete a training course that includes readings, videos, tests, and hands-on equipment review. The training course starts with a student completing online knowledge reviews through e-learning. These knowledge reviews require a student to read textbook material, engaged with interactive videos, and complete short quizzes. Once a student successfully completes the necessary e-learning modules, they must complete two days of classroom work reviewing the online material. Classroom material is reviewed by an instructor and concludes with students completing a final written exam. Those passing the exam then move on to the confined-water portion of the training. Confined-water training normally occurs in an indoor or outdoor pool. Students begin practicing the material they learned through e-learning and classroom instruction. The first test that is conducted in water is a physical swimming test. After students pass and complete the swimming test, they progress to learning all the necessary scuba skills to practice safe and responsible diving. Some of the skills taught are: mask clearing and removal, gear assembly, buddy breathing, diver towing, water entry, hand signaling, buoyancy control, and regulator clearing/recovery. Do they include checking the level of air in the tanks?

### **Physical and Mental Effects**

According to the Professional Association of Diving Instructors (PADI), the human body accumulates and stores nitrogen bubbles in the blood when compressed air is used for breathing underwater (PADI, 2018). Divers are taught to follow a complex system of dive tables to track how much nitrogen is in the body after a dive. The longer and deeper a person dives, the more nitrogen is stored in the blood. The dive tables help explain how much nitrogen is left in the blood and reduces the chances of it becoming toxic. When too much nitrogen is stored in the blood, a diver gets what is called decompression sickness, also called DCS or “the bends”

(PADI, 2018). Many of the training techniques taught to student divers are geared towards preventing DCS. The dive tables used today were developed using research by the U.S. military and the Navy dive tables from the early 1900s.

Diving is strenuous on the body and mind. Mental performance and health have been shown to drop after a 20-minute dive (Pourhashemi, Sahraei, Meftahi, Hatef, & Gholipour, 2016). Because diving can cause a loss in mental performance and health, it becomes even more important that students have the proper training and experience to handle dangerous situations. The decline in mental health and performance can cause a student to easily forget an important scuba skill while diving in a real environment. Enhanced training with immersive video could help supplement for the decreased mental performance.

### **Digital Tools for Learning**

There are a number of different ways one can use technology to help students learn new material. The power and capabilities of these tools are numerous. Some students establish personal learning environments (PLEs) where digital tools are leveraged for growth and development (Dabbagh & Facke, 2017). Students emphasized that PLEs need to have openness and collaboration, along with the use of tools such as search engines, social networking, and videos (Dabbagh & Facke, 2017). Interactive video lectures have proven, through experimental results, that it can significantly improve learning retention and achievement when studying a flipped classroom (Ku, Yang, & Chang, 2019). When referring to a “flipped classroom” the analogy indicates a switching of traditional teaching and learning methods (Ku, Yang, & Chang, 2019). Interactive video lectures and digital tools have been used for years in the classroom. Society is just beginning to engage with incorporating 360 video and immersive content into learning. Aviation is one industry that has successfully been using immersive videos and training

in their instruction. Since the early 1990s immersive virtual flight simulators have been training pilots how to fly and the technology has often experienced hardware and software limitations (Oberhauser, Dreyer, Braunstingl, & Koglbauer, 2018). Now that better hardware and software solutions for video training (AR, VR) is available, it is important to consider leveraging the same training for future scuba divers. Scuba is an action sport. Research has shown that action sport learning is predominately informal and self-regulated (Ellmer, Rynne, & Enright, 2020). Because the learning is less formal, it is important to allow people the best tools and technologies to learn on their own.

Another method of teaching that has been explored in the classroom is gaming. The idea is described as using games along with digital experiences to further student learning by developing immersive, interactive scenarios (Stieler-Hunt & Jones, 2019). Documented practitioner notes show that learning using digital games can benefit student overall learning, though it is not widely utilized, and is often met with barriers in the curriculum (Stieler-Hunt & Jones, 2019). Gaming is an important part of young people's lives today. Individuals are surrounded with game advertisements on mobile devices, desktop computers, and even on television. Gaming also pushes the limits for computer hardware systems. As a result some of the world's most powerful computing consoles are built specifically for gaming and graphics. A tool that can be leveraged to help improve student outcomes while teaching are digital games (Stieler-Hunt & Jones, 2019). Stieler-Hunt and Jones (2019) also discuss when determining the effectiveness of a game in a learning scenario, it is important to understand the context of the environment. Using certain games does not necessarily make sense when trying to teach or perfect a certain skill. The overall idea of gaming as a tool for teaching has also been criticized.

The largest concern around the immersive game experience in the learning environment is addiction (Stieler-Hunt & Jones, 2019).

## **Connectivism**

The way people learn and engage with hobbies and activities have changed with evolving technologies. The ability to share information and techniques about a hobby or specific interest with a community in just a few seconds is something that is relatively new. It has helped form special interest groups that are hyper-focused around a certain hobby or activity and can advance the focus much more quickly today than we could in the past. This phenomenon is known as connectivism. Forty years ago, the speed of creating and sharing knowledge was much slower than today (Chandrappa, 2018). Information and learning can now travel much faster with modern technology advances. Connectivism, which was introduced by George Siemens and Stephen Downes in 2004, is a collaborative way of learning that puts the source of knowledge in a place that is accessible by everyone. This learning theory has shaped the recreational scuba diving industry in numerous ways. Scuba diving, an industry that measures experience by the number of logged dives, can now benefit from the collective sharing of information from millions of people's dive logs. Knowledge is growing faster than ever imagined with tools and resources such as the computer and internet (Jirasatjanukul & Jeerungsawan, 2018) as well as smart devices. Dive communities have been established on websites, online forums, social media groups, and local meetups. These small communities help educate and train some of the most important rescue and safety divers in the world.

Connectivism has also been widely criticized as a learning theory. Researchers and authors recognize connectivism demonstrates how learning may occur in our hyper-digital worlds, but do not necessarily describe it to be a learning theory (Goldie, 2016). Authors note

that it requires much more development and testing to be further considered a learning theory. Goldie (2016) also mentioned that the theory has been criticized because there is a lack of empirical testing data available.

### **Behaviorism**

Unlike connectivism, where knowledge is shared and easily accessed, behaviorism occurs when the learning individual responds to environmental stimuli (Clark, 2018). Behaviorism can be classified as learning that occurs by lecturing, rewarding and punishments, and completing drill exercises (Clark, 2018). This style of learning has been common in modern day education for a long time with students learning from instructor-led classrooms. Students are rewarded with a positive reinforcement (passing grade) or punished with a negative reinforcement (failing grade). Clark (2018) outlined these key aspects to behaviorism and discussed how these actions produce different behaviors. Ayesha (2014) noted that rewards, recognition, and positive reinforcements may cause the behavior to strengthen and negative reinforcement could cause a decrease in the undesired behavior (as cited in Clark, 2016). Behaviorism is largely identified as human behavior that is a function of the environment and remains unknown with the brain being unpredictable (Chandrappa, 2018). When it comes to how learning starts, behaviorists insist that the environment will present a cue or stimulus and the learner will react to this event. After there is a reaction, the learner will be positively reinforced or negatively punished (Clark, 2016).

### **Future Technologies**

Virtual reality (VR), augmented reality (AR), and 360 videos are all relatively new technologies that could shape how students learn in the future. Education can benefit as a whole from technology advancements with the ability to influence and improve student learning with the use of e-learning, VR, multimedia, and AR (Misso, Stephen, Maiseli, & Issaka, 2019).

Virtual reality can be defined as an experience that occurs in a simulated environment that is also interactive and computer-generated with 3D elements, motion, and auditory sensations (Misso, Stephen, Maiseli, & Issaka, 2019). What used to be fantasy or science fiction, virtual reality has become a reality in people's day-to-day lives (McMillan, Flood, & Glaeser, 2017). Google introduced a product called Cardboard that allows users to turn almost any smartphone into a personal immersive iMAX experience (McMillan, Flood, & Glaeser, 2017). This same technology could be used to view scuba instructional videos, placing divers in digital underwater scenarios. According to Blascovich and Bailenson (2011), several decades of research on VR determined people internalize their VR experiences and treat them as real (as cited in Markowitz, Laha, Perone, Pea, & Bailenson, 2018). The use of VR with older demographics has even shown positive results. When given a device that displays a virtual environment, most older participants showed a sense of curiosity and delight (Brown, 2019). As the market continues to develop new digital products, it is important to understand how they might be useful for older consumers in terms of physical, emotional, and social health (Brown, 2019).

### **Scuba Training with VR**

Researchers from the University of Tsukuba in Japan developed an underwater VR and AR test to see how students would react to the underwater environment. Most VR/AR systems are used on land and simulate an underwater environment. Their goal was to create a realistic sense of water in a safe environment such as a pool (Hatsushika, Nagata, & Hashimoto, 2019). This particular work uses VR and AR underwater and provides an entirely unique experience where the user is unable to speak with an instructor or listen to feedback. A more practical use of VR/AR in a training environment would be to allow voice conversations with an instructor for instant feedback or incorporating underwater communications with the system.

## **Discussion**

With the way scuba is currently taught, there are a number of opportunities to incorporate VR and AR environments to help students prepare for a real diving scenario. When students watch videos during the e-learning portion of training, a VR or 360 video module could show students how to properly complete certain skills. Students could better understand proximity, how to enter or exit the water on a boat, how to follow a mooring line, how to complete a safety stop, how to perform a search and recovery, diving with a current, and diving with low visibility. Most of the conditions are discussed in the e-learning material or the book, but could be further explained with immersive technology. It is important to remember that diving causes physical and mental stress with a proven reduction in mental performance and health. With these known conditions, having the most practice and knowledge of these situations could save a diver's life.

## **Conclusion**

Scuba diving is an exciting sport, allowing people to discover and enjoy our oceans and underwater environments. Scuba also has specific dangers if proper training and techniques are not practiced. Using technology and immersive VR experiences, scuba diving could be taught in a more interactive way. Digital tools have significantly advanced in the past several decades. What used to be very expensive and impractical for the everyday consumer to utilize, VR and AR capabilities are now shipped on modern day smartphones. The advances of scuba as a sport are largely due to technology and equipment advances. Adding these new training techniques could further evolve the sport and bring it to areas and people that have never experienced diving before.

Students and learning are also advancing and evolving. With connectivism, students can contribute to knowledge by sharing and collaborating with our advancing toolkits. Research has

shown that students place priority on collaboration and organization when asked what is important in digital learning. Despite all of these emergent tools and evolving theories, there are still gaps and opportunities in training for scuba diving. Today's training and techniques do not provide enough information about diving from a boat or how to prepare for the different ocean environments. Virtual reality and 360 videos could help students recognize the conditions and better prepare them to be safe, responsible divers.

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