



Diving into SDG 14, Life Below Water: A VR Experience for Deeper Understanding

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Abstract. The United Nations' Sustainable Development Goal (SDG) 14: Life Below Water aims to conserve and sustainably use the oceans, seas, and marine resources for sustainable development. However, the complexity and vastness of the ocean can make it difficult for students to fully understand and care about marine conservation and the sustainable use of ocean resources. In this session, we propose using FrameVR to design an immersive learning environment that promotes deeper engagement with SDG 14 by providing students with an interactive opportunity to explore the current state of the ocean and the effects of human activities on marine life. One of the key features is integrating real-world data from carefully curated and reputable educational media to ground the learning, including infographics, Tik Tok and YouTube videos, images, audio lessons, personal stories, articles, and learning games. A social component allows students to work together in developing solutions to the challenges they encounter in the FrameVR experience. By creating an environment that will enable them to explore, learn, and collaborate with peers, we aim to enhance student awareness, engagement, empathy, and motivation to take action on SDG 14.

Keywords: Immersive Learning, Sustainability Education, Ocean Ecology, Marine Conservation.

1 Defining the Need

Ocean acidification is one severe result of climate change due to increasing carbon dioxide concentrations in the atmosphere, causing the marine environment to be negatively impacted in various ways [1]. Carbon dioxide levels are causing marine animals to die, fish populations to dwindle, struggles for phytoplankton to reproduce and bleaching of coral reefs due to potent levels. Societies heavily rely on the ocean for food supply, employment, energy, and recreation. As Nash et al. [2] argue, it is imperative that societies take responsibility for marine citizenship and “counter undesirable ocean-human health feedbacks and promote desirable interactions to address pressing sustainability issues at the intersection of ocean and society,” or we face irreversible outcomes for both ocean and human health.

To begin rectifying the situation, in 2015, the members of the UN signed an agreement valuing the importance of sustainable development. The agreement has 17 goals subdivided into multiple learning targets. It aims to improve each country’s “health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests” [3]. Each country is responsible for meeting specific targets in the areas of environment, economy, and society by 2030 to improve the overall wellness of the country, specific to the 17 goals for sustainable development [4, 5]. Although the agreement was signed nine years ago, there is still a serious lack of SDG education in societies and schools, harming the success of reaching specific targets on time.

The Canadian Government declared that climate change is critically impacting our oceans and marine communities through biological impacts, reduced quantity of marine species and adding damaging pollution to

our water sources forcing the need to support our oceans and water systems [6]. This declaration aligns with SDG 14: Life Below Water, “conserve and sustainably use the oceans, seas and marine resources for sustainable development” [3]. Students of Alberta and Saskatchewan live in prairie provinces with land borders. They are not only geographically isolated from seeing the damage to our oceans, seas, and marine resources firsthand, but also lack vital information to invoke change. While students may not feel personally connected to SDG 14 due to local industry or living in a landlocked location, they need to understand the severe impacts our oceans have on their quality of life. Additionally, many K to 12 teachers are reluctant to implement sustainable development subject matter in their curriculum due to low self-efficacy and lack of knowledge surrounding the SDGs [7, 8]. Designing a high-quality educational environment in FrameVR will help teachers and students bridge gaps in their understanding of SDG 14, which is critical to supporting alignment with sustainability targets on reducing marine pollution and preserving the health of our oceans.

2 Solving the Need

In response to the need for meaningful and relevant education on the United Nations SDGs, we designed a FrameVR environment that focuses explicitly on the learning targets for Goal 14: Life Under Water. According to a study by Garduno et al. [9], students expressed that using virtual reality (VR) to learn high school science curriculum was favourable, showing 72% positive for attention and 71% positive for satisfaction. Additionally, VR can extend students’ perceptions and presence outside of the classroom to areas of the world where field trips and experiences often are not reachable in specific settings [8], [10]. Our project takes inspiration from Mensink et al. [11], who developed Marine XR using design principles of gamification, simulation, role-playing, and immersion to make it engaging for learning about ocean conservation and environmental sustainability. Further, we build on the work of Xu et al. [12], who explored the efficacy of a VR simulation on rising sea levels (using prediction data), which was an effective approach for teaching about the urgency of the climate crisis.

Learning in an immersive environment can provide a meaningful opportunity for students in the prairies to explore, collaborate, and make connections about our oceans and waterways (beyond passive engagement with text and images or watching videos). The FrameVR space places students in an environment far removed from their prairie setting to take a first-hand look at the human impacts on oceans and the threats they face. It also provides educators with an easy way to facilitate SDG learning no matter what previous background knowledge they may have through virtual scenes and micro-learning content for students to construct knowledge, skills, and attitudes for SDG 14. To enhance engagement and interest within the FrameVR environment, we carefully curated educational media from reputable sources, including interactive polls, Padlet brainstorming, images, infographics, Tik Tok videos, YouTube videos, audio lessons, articles, pdf documents, personal stories, and learning games.

The FrameVR environment is divided into three sections: Overview, Prevention/Protection and Current Events/Efforts. Each section has discussion and inspiration areas that act as a gathering place for students near and far to discuss their thoughts and feelings about SDG 14. In the gathering area, students can collaborate and receive feedback and advice from peers, teachers, and subject matter experts to enhance their understanding of SDG 14.

- 1) The Overview section provides students with a broad range of information that explains and breaks down the main components of SDG 14 (see Fig. 1).
- 2) The Prevention/Protection section challenges students to dig deeper into the kinds of efforts they can begin incorporating into their daily life to help contribute to the betterment of our world and healthy oceans (see Fig. 2).
- 3) In the Current Events/Efforts section, students get a glimpse of the current issues in SDG 14. They have an opportunity to gain inspiration from the innovative efforts happening in Canada and around the world in support of SDG 14 (see Fig. 3).



Fig. 1. The Overview section of the immersive learning environment.



Fig. 2. The Prevention/Protection section of the immersive learning environment.



Fig. 3. The Current Events/Efforts section of the immersive learning environment.

3 Project Goal, Targets, and Objectives

The project aims to develop a meaningful, interactive, and immersive learning experience in FrameVR using micro-learning content to support high school students in developing knowledge, skills, and abilities toward SDG 14. Two specific targets defined by the United Nations [3] provide a sense of direction and clear focus for the project design: “By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution” (target 14.1) and “Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels” (target 14.3). See

Table 1 for the FrameVR project’s learning objectives that are specific, measurable, achievable, relevant, and timely (SMART).

Table 1. Learning objectives corresponding with the SDG targets.

SDG Target [3]	Learning Objective
13.1	The student understands the greenhouse effect as a natural phenomenon caused by an insulating layer of greenhouse gases.
13.2	The student understands climate change as an anthropogenic phenomenon resulting from increased greenhouse gas emissions.
13.3	The student knows which human activities – on a global, national, local, and individual level – contribute most to climate change.
14.1	The student understands basic marine ecology, ecosystems, predator-prey relationships, etc.
14.2	The student understands the connection of people to the sea’s role as a provider of food, jobs, and exciting opportunities.
14.3	The student knows the basic premise of climate change and the role of the oceans in moderating the climate.
14.4	The student understands threats to ocean systems (e.g., pollution and overfishing), and can explain the relative fragility of many ocean ecosystems (e.g., coral reefs and hypoxic dead zones).
14.5	The student knows about opportunities for the sustainable use of living marine resources.

4 Assessment Design

Education is critical to raise awareness of the importance of ocean ecology and marine conservation [11], [12]. To help students understand the abstract nature and complexity of human impacts on marine ecosystems, immersive learning and visualization can effectively illustrate the problems and create opportunities for students to collaborate on sustainable solutions. The next step for this project is to evaluate the FrameVR with students and teachers; we will improve the learning environment with their feedback. Formative and summative assessment approaches will provide a detailed report of student learning.

4.1 Formative Assessment

Before students enter the FrameVR, it is important that teachers lead a formative discussion or quiz to discern the students’ background knowledge of SDG 14. Throughout the FrameVR, there are additional formative assessment activities in the learning journal and quizzes that serve to document learning and growth. For example, when students join the Padlet conversations they can connect with other students, teachers, and subject matter experts to receive feedback and support in knowledge development. Within the FrameVR environment, students are expected to participate in all formative assessments (in each of the three sections) alongside other students to develop their knowledge, skills, and attitudes around SDG 14. At the beginning of each section, a checklist guides students to meet the required outcomes. These checklists align with the learning journal connected to the FrameVR environment.

4.2 Summative Assessment

Students have a variety of summative learning opportunities to demonstrate mastery of content. For example, students can use the learning journal template to express their understanding of the learning targets in the FrameVR environment. Within the learning journal, teachers can use the written component to assess student comprehension of the SDG content. Each teacher will be responsible for assessing student mastery of the learning objectives based on their local standards and program of studies. Teachers should use rubrics that align with their

practice and school division requirements for assessing student learning. Teachers should also ensure that students understand the rubric expectations before assessing their work.

Once students have constructed knowledge, empathy, and understanding of SDG 14, teachers should challenge them to put their learning into action. For example, students can be encouraged to participate in the Caring for Our Watersheds Student Competition [13], where they design a solution to support the care of local water sources feeding into our oceans. We encourage teachers to check out the competition link to see if this interdisciplinary project is a good fit for their class. We hope that the result of the FrameVR immersive learning experience motivates students to create an innovative project to protect the ocean through their local watersheds.

5 Conclusion

The sustainable use of the world's oceans, seas, and marine resources (SDG 14) is a pressing global issue that requires urgent attention. However, educating students about SDG 14 can be challenging in traditional classroom settings as the ocean is vast, complex, and difficult to visualize or experience first-hand for many students, especially those living in landlocked areas. This lack of direct exposure can make it hard for students to connect with the importance of marine conservation and the sustainable use of ocean resources. Hands-on or experiential learning opportunities, such as field trips or oceanographic research, are expensive, time-consuming, and often require specialized equipment and interdisciplinary expertise beyond what is available in a subject-based school curriculum. Motivating students to take action on SDG 14 can be difficult due to the perception that the issues are too big for individual efforts to matter, leading to a sense of helplessness or feeling overwhelmed.

We used the affordances of FrameVR to promote deeper engagement with SDG 14 by providing students with an interactive opportunity to explore the current state of the ocean and the effects of human activities on marine life. Students can enhance their understanding of the issues by learning with real-world data from reputable sources and educational media, including infographics, videos, images, games, and personal stories. We expand assessment research by demonstrating what meaningful assessments look like in an immersive learning environment where students learn and develop sustainable solutions together. From our perspective as educators and designers, we believe that immersive learning experiences have the potential to inspire a new generation of environmental stewards and ocean conservationists who are motivated to spread knowledge and awareness of how we need to conserve and sustainably use ocean resources that are essential to human existence and life on our planet.

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