# Developing Virtual Reality Learning Materials for Elementary Marine Education using the ASSURE Model

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***Abstract:*** *This study developed marine education virtual reality (VR) materials, employing the ASSURE model for instructional design. Utilizing the CoSpaces EDU platform, we designed an immersive VR escape room game that simulates a real marine environment. This VR allows students to become acquainted with Taiwan's marine society, culture, and resources, fostering an appreciation and awareness for the sustainable development of marine environments and resources. Expert evaluations have affirmed its effectiveness, and future teaching experiments will be conducted in elementary schools to verify its learning outcomes.*

**Keywords:** ASSURE model, E-Learning, Integrated Curriculum, Marine Education, Virtual Reality

## 1. Introduction

Taiwan, as a nation surrounded by the sea, boasts a diverse range of coastal topographies, geologies, and a wealth of marine life, including world-class coral reef ecosystems. The government has been actively promoting marine education through the release of relevant policies and the establishment of curricula, garnering widespread attention for marine education. The Ministry of Education's "National Ocean Policy White Paper," published in 2020, incorporates marine education into its critical agenda, aiming to construct an ecological, safe, and prosperous sustainable maritime nation. The twelve-year national basic education curriculum also integrates marine education (Twelve-Year National Basic Education Curriculum Guidelines, 2020) to enhance students' understanding of the sustainable development of the marine environment and resources.

This study utilized the CoSpaces EDU web platform to construct virtual reality learning materials, combined with an immersive escape room game, to simulate a realistic marine environment. This enables students to understand Taiwan's marine society, culture, and resources, and to strengthen their affinity for the ocean. The game in this VR is divided into three major levels, where students must unlock each level to become "Children of the Ocean." Based on the ASSURE model for instructional design, marine education is integrated into virtual reality (VR), aimed at guiding middle and high-grade elementary school students to value the concept of marine sustainable development and establish a foundational understanding of the sustainable development of the marine environment and resources.

## 2. Literature Review

Marine education has recently garnered global attention due to issues like global warming, extreme climate events, ocean pollution, and the depletion of marine resources. The methods of promoting marine education are varied, including role-playing, systematic teaching, competency education, and the integration of technology into curricula. These approaches underscore the importance placed on the philosophy and advancement of marine education, incorporating sustainable marine education into teaching activities to encourage positive student engagement and concern for marine issues. Consequently, this study aims to develop a more diverse range of marine education content,

breaking through environmental limitations by employing gamification and digitalization. This will stimulate students' learning interests, offering teachers and students a wealth of vivid options, making marine knowledge more accessible and shareable. Such efforts will advance marine education and collectively protect our precious oceans.

With the advancement of technology products, Virtual Reality (VR) allows learners to interact with learning materials through the VR system. It provides learners with an immersive experience and offers opportunities for repeated practice, thereby providing a more realistic, flexible, and effective learning environment (Chen, Chen, & Li , 2022). Using VR as a learning technology provides students with a context for active learning. Users can freely decide where to go in the environment and can find additional information through the VR interface (Wu, Manabe, Marek, & Shu, 2021). Therefore, this study uses VR to provide students with a learning experience that encourages active exploration and interactive collaboration. It has rich extensibility, allows students to feel a sense of presence and immersion to explore different scenes and learning objects, and enhances learning effectiveness.

The ASSURE model of instructional design, proposed by Heinich, Molenda, Russell, and Smaldino in 2002, encompasses six steps: Analyze learners, State objectives, Select instructional methods, media, and materials, Utilize media and materials, Require learner participation, and Evaluate and revise. The ASSURE model is widely applied in education, integrating educational technology, generating interest and motivation through gamification, developing interactive course designs, and focusing on issue-based material creation to improve teaching practices and learning outcomes. Its goal is to enhance students' understanding and participation across various educational domains by incorporating interactive elements, multimedia resources, and learning activities, providing insights for future related material design. Therefore, this study, based on the ASSURE model, targets middle and high-grade elementary students, integrating virtual reality (VR) into marine education. We develop VR materials as teaching mediums, demanding active student participation in the learning process.

## 3. Research Method

This study first determined the research methodology and topic before confirming the research background and purpose. After reviewing relevant literature, the framework of the VR materials was studied and marine education VR materials were developed using the CoSpaces EDU web platform. Questionnaire surveys were conducted and experts were invited to evaluate the materials and provide suggestions for revisions. In the future, teachers can integrate these VR materials into elementary school science curricula and conduct teaching experiments. Related knowledge can also be delivered through the digital education process. The following is the research procedure, as shown in Figure 1.

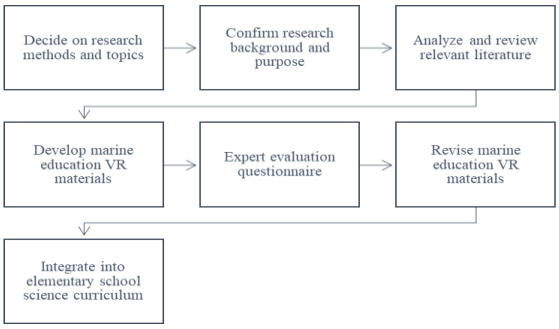


*Figure 1. Research Procedure Flowchart.*

The following points are the learning objectives: (1)Analyze Learner Characteristics: Targeting middle and high-grade elementary students with physical manipulation and logical computation abilities, we aim to engage them beyond anthropomorphic thinking. Thus, we employ escape room methods to captivate students, combining fun interactions and challenging learning experiences. (2)State Objectives: To establish students' understanding of the ocean through lively and interesting marine exploration using virtual reality technology. (3)Select, Modify or Design Materials: We use the

CoSpaces EDU platform to develop materials, providing a wealth of 3D models and scenes for an immersive experience of marine ecology and conservation issues. Materials are designed according to instructional goals and optimized based on feedback from experts and users. (4)Utilize Materials: Ensuring that instructional equipment, environments, and resources are prepared, we attract students' attention and resolve queries, encouraging proactive exploration and discovery to enhance learning motivation. (5)Require Learner Response: Student satisfaction and suggestions for the materials are collected through surveys to facilitate clear improvements and enhance material effectiveness. (6)Evaluate: Assessments include marine knowledge, conservation, ecology, and usability to confirm instructional effectiveness and further optimize materials.

The "VR Material Evaluation Questionnaire" developed in our laboratory encompasses five dimensions: "Learning Value," "Curricular Inspiration," "Interface Design," "Pre-assessment," and "Post-assessment." The overall questionnaire consists of 27 items with a Cronbach's Alpha value of .967, indicating a high reliability. A Cronbach's Alpha value above .80 is considered optimal, signifying very high reliability suitable for measurement purposes. Therefore, the scale of this study has high reliability and is appropriate for implementation, allowing for the evaluation of teaching materials.

*Table 1. Cronbach's Alpha values for each dimension in the expert evaluation of marine education VR teaching*

| Dimension | Number of questions | Cronbach's Alpha |
|---|---|---|
| Learning Value | 1-5 | .879 |
| Course Inspiration | 6-9 | .846 |
| Interface Operation | 10-16 | .907 |
| Pre-assessment | 17-19 | .873 |
| Post-assessment | 20-27 | .945 |
| Overall scale | | .967 |

## 4. Research results

This study employs the CoSpaces EDU web platform for developing a virtual reality (VR) material of marine education. With the flourishing development of digital media, interactive elements in virtual spaces have enhanced the enjoyment of learning, making the overall materials more engaging. The marine education VR materials aim to direct students' attention to environmental issues and the protection of marine ecosystems by means of game-based learning. The first level, "Discovering Fantastical Marine Creatures," involves recognizing marine life and unlocking code locks. The second level, "Ocean Defense Battle," adopts a situational approach to collect marine debris and answer related questions to unlock doors. The final level, "Voyage to the Ocean – A Feast Journey," introduces Taiwan's famous fishing festivals and unique marine creatures, with interactive elements triggering the gateway for students to soar through the ocean. The developed VR material of this study is illustrated in Figures 2 to 4.

*Figure 2. Marine Education VR Materials - Level One 'Finding Fantastic Marine Creatures*

*Figure 3. Marine Education VR Materials - Level Two 'Marine Defense War*

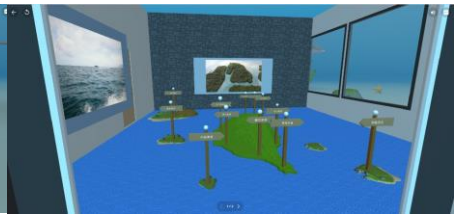

*Figure 4. Marine Education VR Materials - Level Three 'Embarking on the Ocean - Feast Journey*

Upon completion of the marine education VR materials, this study invited 33 experts for testing and evaluating it. The results were analyzed using descriptive statistics and a one-sample t-test (test value set at 3). The consolidated dimensional analysis results are presented in Table 2.

*Table 2. Descriptive Statistics and One-Sample t-Test Summary of Expert Evaluation Results*

| Dimension | M | SD | $t_{(32)}$ |
|---|---|---|---|
| Learning Value | 4.45 | .590 | 14.161*** |
| Course Inspiration | 4.58 | .482 | 18.779*** |
| Interface Operation | 4.11 | .737 | 8.673*** |
| Pre-assessment | 4.22 | .725 | 9.686*** |
| Post-assessment | 4.49 | .568 | 15.081*** |

****p<.001*

After evaluation, experts have made suggestions for the marine education VR materials. This research has compiled the following three points of feedback:

(1) Objects within the level should not be purely decorative, such as the books on the bookshelf, which can be opened to view marine-related knowledge.

(2) When entering the level, the way to play is added to the operation mode description.

(3) The overall game design is thoughtful, with good intentions, and can interact with VR, which is a brand new experience for learners.

In summary, experts believe that this marine education VR curriculum holds significant educational value. They particularly emphasize its interactivity and the diverse learning scenarios, which enhance learning engagement and increase learning effect.

## 5. Conclusion

In this study, we developed a marine education VR material for elementary students using the ASSURE model. After evaluation, experts confirmed its effectiveness in enhancing learners' understanding of marine knowledge and conservation issues. The immersive VR technology provides a realistic experience, deepening comprehension of the ocean. Future teaching experiments will be conducted for examing its effect of VR in learners' attitudes, interests, and achievements, marine education sustainability concepts and emotional connections to ecological issues. These findings inform VR material development across disciplines.

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