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Mapping the ocean literacy essential principles and fundamental concepts in the movie avatar: The way of water for high school students

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ABSTRACT

Ocean literacy competences are important for Indonesia as an archipelagic country, yet it's integration into learning remains limited. Popular movie *Avatar: The way of water* can used as alternative learning media to introduce ocean-related concepts. This research aimed to connect and map the 7 essential principles and 45 fundamental concepts of the ocean literacy in the movie *Avatar: The way of water*. Type of research conduct was qualitative research with semiotic method that had been done by identified detonative and connotative signs with data sheets concepts map as an instrument. Research had been conducted by identification of scenes, dialogues, and narrations on the whole duration movie. After that, mapping of the key scenes had been done as samples to be analysed. All the scenes, dialogues and narrations be identified for the ocean representation. Then, all the samples been categorized to connect with ocean literacy that had been globally developed by NOAA and UNESCO-IOC. Data had been qualitative analysed by comparison for each scene, dialogue and narration based on principles and concepts of ocean literacy. The results showed that movie of *Avatar: The way of water* contains 6 essential principles and 11 fundamental concepts of ocean literacy. It means that movie of *Avatar: The way of water* can be used for learning resource of ocean literacy.

INTRODUCTION

In the context of biology education, scientific literacy involves grasping scientific principles, exercising scientific logic, and utilizing this knowledge to inform data-driven choices and resolve issues (Gormally et al., 2012; OECD, 2019). However, learning abstract biological concepts, particularly marine biology and ocean literacy, often poses challenges due to limited direct field experiences. Hulwah & Suriani (2025) emphasized that connecting elementary science lessons to real-world experiences significantly improves students' understanding, engagement, and overall scientific development. To bridge this gap, technology-driven contextual experiences through digital media such as movie (Shackleford et al., 2026). Among these media, the sci-fi movie Avatar: The Way of Water offers profound implications for experiental learning by integrating cinematic narratives with authentic ecological and anthropological phenomena.

James Cameron, as both writer and director, has created Avatar: The Way of Water, inspired by the Bajo tribe scattered across the small and remote islands of eastern Indonesia. This was also confirmed in research by Julfan (2024) which concludes that the Bajo tribes and Metkayina tribes in the Avatar: The Way of Water share similarities in their knowledge systems regarding survival by utilizing marine resources. Furthermore, research by Arhesa et al. (2025) and Ilardo et al. (2018) also examines the subsistence lifestyle that often involves diving, giving the Bajo tribe extraordinary diving skills. The study was supported by comparative genomic data showing that natural selection of certain genetic variants has increased the size of the spleen in the Bajo people, allowing the reservoir of red blood cells to bind more oxygen.

Through the physiological and morphological adaptation of the Bajo tribe, it can be indicated that the sea not only has implications for coastal communities but also affects human survival in general (Maulidyna et al., 2021). This is in line with the principles of ocean literacy by *National Oceanic and Atmospheric Administration (2013)* which explains that the sea affects human life and vice versa. Even a researcher from the Oceanography Research Center at the National Research and Innovation Agency (BRIN), Puji Rahmadi, revealed thet the value of Indonesia's marine wealth reached IDR 1,772 trillion in 2019 (as cited in Koharudin et al., 2021). Therefore, knowledge about the ocean is necessary as an effort to foster concern for the marine environment. Santoro et al. (2017) stated that almost all research about the ocean is new and underdeveloped, and all of us must work together to improve this by doing what we can to bring marine studies closer to everyone. According to Kelly et al. (2022), education and social connections can be a method to engage the ocean literacy of the public, especially for Indonesian people. The Avatar: The Way of Water is set in the marine ecosystem of the planet Pandora with visuals resembling planet Earth. The narrative and conflicts presented can also be used as a learning resource to introduce marine awareness, although it does not explain the principles of ocean literacy in a complex manner. Movie as learning resources need to be studied, observed, and learned so that they can be used as material to be mastered. Therefore, this study will further examine the relationship between the Avatar: The Way of Water and the principles of ocean literacy.

METHODS

Research Design

This research is a qualitative research accordance with Wahyudi et al. (2023) which explains that qualitative research is research with methods that emphasize depth of information. The information in this case includes primary data in the form of visual and narrative data from the movie Avatar: The Way of Water, obtained through observation of the entire movie. Umar Prayogo (2021) also explains that observation is a data collection technique conducted through direct observation accompanied by recording the conditions or behaviour of the research object. The distribution and demographic characteristic of the selected movie segments analyzed in this study are detailed in Table 1.

The analysis in this study is limited to segments of films that contain visual and narrative elements related to the ocean. Visuals include background displays, forms of living creatures, and movements/actions of characters that refer to the ocean. Meanwhile, narratives include dialogues between characters, monologues or individual/internal conversations, and narrations by narrators that also refer to the ocean.

Table 1.
Demographic and segment distribution of Avatar: The Way of Water Data

Data Type	Source	Criteria
Visuals	Background displays, marine creatures	Scenes depicting ocean ecology
Narratives	Dialogues, monologues, narrations	Conversations related to ocean literacy

Secondary data includes literature studies. Therefore, data presentation is carried out descriptively through verbal or written expressions from individuals as well as observable behaviour in the movie. Descriptive research explains the basic conditions of various phenomena to develop theories to explain the relationships between phenomena (Adiningrat et al., 2025).

The focus of this research uses semiotic analysis by Barthes (1988). Wibisono & Sari (2021) explains that semiotics is the study of signs, one of whose leading figures is Roland Barthes, who developed two levels of signification: denotation (actual meaning/fact) and connotation (non-actual meaning/interpretation) to be used in recognizing and understanding the implied meaning (myth) presented. Therefore, the researcher acts as the main content analyst or key instrument in this study. To ensure the validity and reability of this qualitative analysis, the researcher applied theoretical triangulation method and member checking through FGDs with experts. This system ensures that the interpretation of visuals and narratives data regarding ocean literacy is objective and rigorous.

Population and Samples

Population is all people or cases or objects that form the basis for generalizing research results (Swarjana, 2022). The population in this study includes all audiovisual content in the movie Avatar: The Way of Water, which has a duration of 3 hours and 12 minutes. The audiovisual content recorded includes visual scenes and narration (by the narrator, dialogue, and monologues) contained in the movie Avatar: The Way of Water.

Sample is a selected part of a population that selected through a sampling method in research (Swarjana, 2022). The sampling technique used was purposive sampling. According to Ani et al. (2022) purposive sampling means sampling based on considerations or criteria that have been formulated in advance by the researcher. In the context of this study, the samples used had criteria, namely key scenes that had visuals or narratives that directly represented the characteristics of the sea and the interactions of living creatures in it, which were then analyzed using concepts from the principles of ocean literacy.

Instruments

This qualitative study uses main instruments and supporting instruments. The main instruments in this case are the researchers' ability to observe and interpret scenes based on their understanding of ocean literacy and literature studies discussed in the focus group discussion (FGD). The supporting instruments are tools used to present the data obtained by researchers. The supporting instruments used are data sheet, coding guidelines, and software. Data sheet is written sheet containing systematic tables for collecting data in the form of scene codes, timestamps, analysis units, principal identification, and analysis descriptions. The codification guidelines include operational definitions of the seven principles of marine literacy and a mapping of the concepts published by National Oceanic and Atmospheric Administration (2013), and general theme indicators for key scenes. The software used was the Netflix movie player to accurately identify timestamps and Microsoft Excel as a recording tool. The data obtained by researchers will be validated through focus group discussion (FDG) with experts.

Procedure

The research conducted was qualitative research carried out without location restrictions for six months. The process began with preparation for data collection through initial observation of the entire movie, recording the conditions or behaviors of the research object (Umar Prayogo, 2021). Therefore, the research stages included: (1) Preparation; to understand the context and chronology of the story. This step is essential for developing observational indicators for sampling purposes, aligning them with NOAA's Ocean Literacy conceptual mapping (Table 2).

Table 2.
Mapping of ocean literacy concepts by NOAA and UNESCO-IOC to theme scenes indicators

Code OL Principles	Concepts Code	Fundamental Concepts	Theme Scenes Indicators
OL1	**1A**	Ocean as a connected and dominant global system	Physico-chemical system & geographical **(Code: OL.A)**
	1B	Diverse geological characteristics of the ocean	

Code OL Principles	Concepts Code	Fundamental Concepts	Theme Scenes Indicators
	1C	Ocean circulation connects ecosystems and energy distribition	
	1D	Earth changes affect sea level dynamics	
	1E	Physico-chemical characteristics of the sea	
	1F	Ocean cycle	
	1G	The sea as an estuary	
	1H	Marine resources are limited	
OL2	**2A**	The sea forms rocks	Physico-chemical system & geographical **(Code: OL.A)**
	2B	The sea changes the land	
	2C	Ocean currents erode the coast or land	
	2D	Ocean is the largest reservoir of cycling carbon on Earth	
	2E	Physical activity by the sea changes the shape of the coast	
OL3	**3A**	Sea as weather control	Physico-chemical system & geographical **(Code: OL.A)**
	3B	Ocean absorbs a lot of solar radiation	
	3C	Interactions in the ocean trigger phenomena	
	3D	Condensation produces energy	
	3E	The ocean dominates productivity	
	3F	Ocean changes affect climate	
	3G	Ocean changes have broad impacts (ecological, economic, and social)	
OL4	**4A**	Marine organisms produce oxygen	Ecological & Biological **(Code: OL.B)**
	4B	The sea as a place where ancestors were found and evolved	
	4C	The ocean provides resources for life	
OL5	**5A**	The size of marine organisms varies	Ecological & Biological **(Code: OL.B)**
	5B	Marine organisms as primary producers	
	5C	Higher diversity in the sea	
	5D	Important relationships between organisms occur in the ocean	
	5E	The ocean has a living space with a unique ecosystem	
	5F	Environmental factors shape marine ecosystem	
	5G	Deep sea independent of solar energy	
	5H	There is a vertical coastal zone pattern	
	5I	Estuaries provide nursery areas for many marine species	
OL6	**6A**	The ocean affects every human life	Socio-environmental and human impacts **(Code: OL.C)**
	6B	The ocean as a source of livelihood	
	6C	The ocean as a cultural element	
	6D	Humans affect the ocean	
	6E	Changes in ocean environment have an impact on the survival of living things	
	6F	Much of the world's population lives in coastal areas	
	6G	Everyone is responsible for caring for the ocean	
OL7	**7A**	The ocean is the largest unexplored place	Socio-environmental and human impacts **(Code: OL.C)**
	7B	Understanding the ocean through exploration, experimentation and discovery	
	7C	Research on the sea increases	
	7D	The role of technology in marine research	
	7E	The urgency of modelling in ocean research	
	7F	Interdiciplinary marine exploration	

(2) Data process; include sampling and analysis data. Scene sampling was conducted using the instrument indicators validated in stage one. The identified key scenes were then tabulated in a data sheet before undergoing semiotic analysis based on Ronald Barthes' framework. Data process also include categorizing the key scenes analysis results into ocean literacy principles; all processed data were then validated through FGDs and a literature study. (3) Conclude; generalize all of concept in stage two to formulate an ideology that the audience can internalize and apply. The systematic procedure of this research is illustrated in Figure 1.

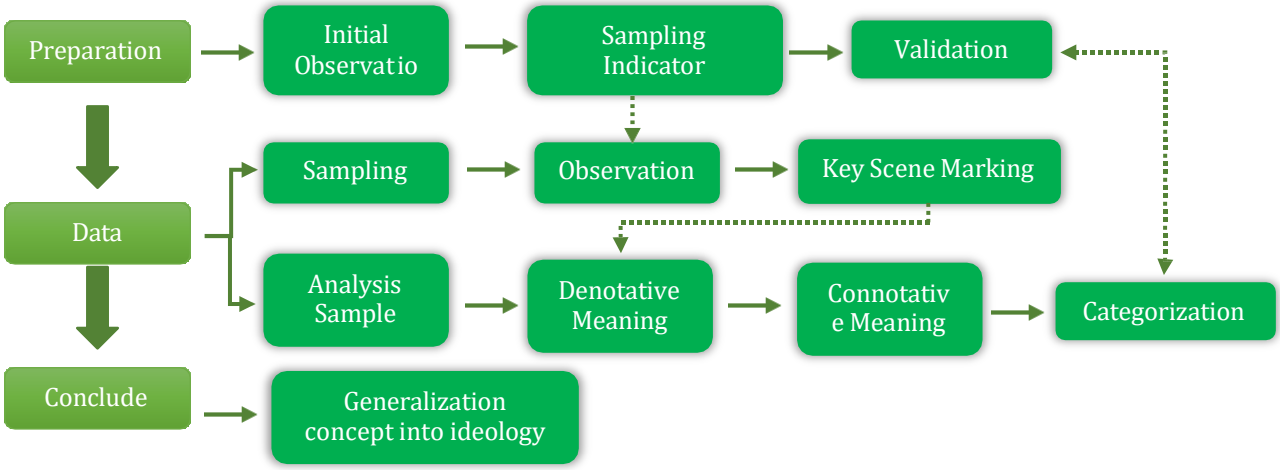

Figure 1.
Systematic procedure of research.

Data Analysis Techniques

This study uses Ronald Barthes' semiotic analysis with modified stages: (1) Data reduction, by collecting scenes based on general criteria described by Barthes' coding, primarily reference codes (referring to science and being factual, educational, and objective), symbolic codes (referring to the contrast between two things to create deep emotional meaning), and semi-codes (referring to the nature or character of an object in a movie); (2) Two stages significance: the results of scene identification will be analysed denotatively or presented with direct descriptions according to observations, then reanalysed for connotative messages or meanings; (3) Interpretation and connotative meaning will be categorized based on the operational definition of the concept of ocean literacy, and conclusions will be drawn about the ideology contained in the film from the accumulated meaning of the scenes found. The data found will be validated using focus group discussions supported by literature studies.

RESULTS AND DISCUSSION

Based on observations and identification of the Avatar: The Way of Water movie, researchers collected key scenes, dialogues/monologues, and narratives using cultural, symbolic, and semiotic codes based on general criteria, namely visuals such as backgrounds and living creatures or narratives relevant to the theme of the ocean. The findings show that there are 22 key scenes that meet the general theme. The analysis results were then categorized into 7 principles of ocean literacy with the distribution and frequency of scenes shown in the scene mapping chart. (Figure 2).

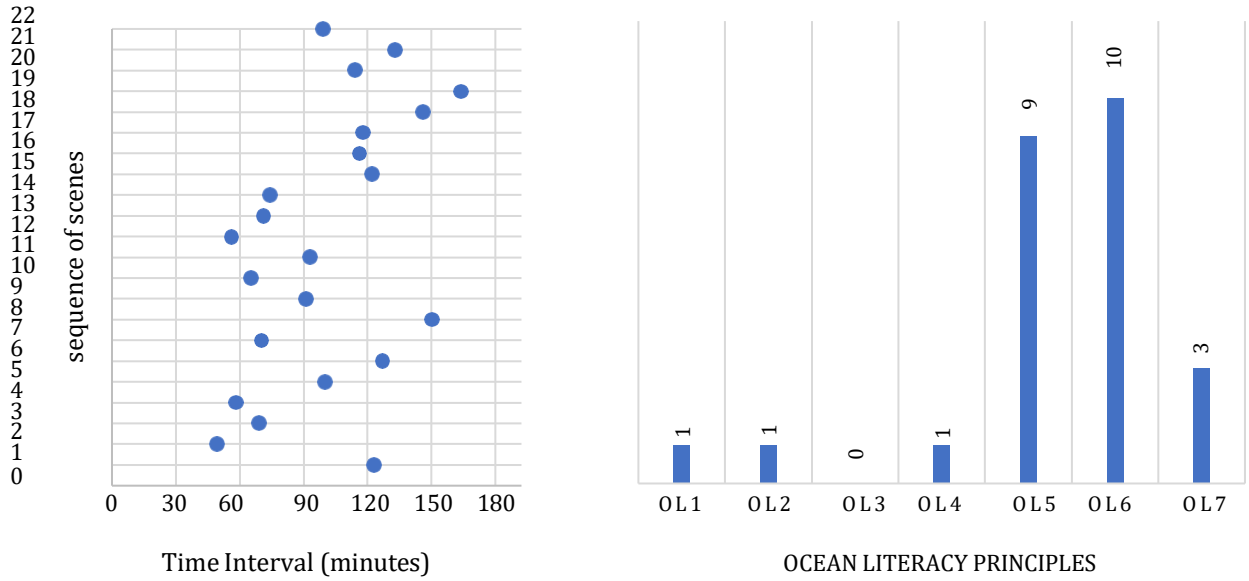

Figure 2. Mapping of key scene distribution based on time intervals and scene frequency based on ocean literacy principles categories.

Based on the graph in Figure 2 scenes frequency mapping shows that the density of scene samples throughout the duration of Avatar: The Way of Water is between the 50th and 170th minutes. This is because during this interval, the film's narrative and setting shift to the ocean environment of Pandora. Based on the analysis results, several theme indicators scenes are dominant which distributes in many key scenes such as OLB and OLC. Below the analysis results:

OLB. Ecological & Biological Key Scenes

In this scene (Figure 3), Lo'ak is shown adjusting his body rhythm underwater for respiratory efficiency, accompanied by the narration, “Water has no beginning and no end. The ocean is around you and within you.” This narration directly represents the 4A concept of ocean literacy, namely the role of the ocean as the largest source of oxygen on Earth. This is influenced by the power of photosynthetic microorganisms in the oceans, which contribute more than a half of the Earth's oxygen production (Regaudie-de-Gioux et al., 2014). Lo'ak's breathing pattern became a physical symbol of living creatures' dependence on the gas elements provided by the marine ecosystem. Connotatively, the statement that “The sea is within you and was present before you were born until you die” shifts the meaning of the sea from a mere geophysical object to a spiritual subject that is considered the “Womb of the World” where humans must not be reckless towards the sea. The womb of the world is described as a place that gives life and accommodates death. Both directly and indirectly, the ocean provides vital resources for life around it, as outlined in the 4C principle. Yusuf et al. (2023) also explain that the ocean plays a vital role in supporting life around it by providing nutrients and living space for various organisms, thus necessitating protection efforts.

Figure 3. Lo'ak breathing practice.

This interpretation is reinforced by the scenes in Figure 4, which are cultural codes that display visuals resembling trees that store the memories of the Na'vi ancestral "spirits." The existence of these organisms denotatively illustrates the principle of the 5E concept, where the ocean provides a vast living space with unique ecosystems from the surface to the seabed. The seabed in the Ancestral Bay is the center of biological and spiritual life that connotes the function of the Spirit Tree as a center of life that validates the metaphor of the "Womb" as a place where life is rooted and stored. This connotes that the sea as a "womb" not only gives birth to physical living creatures but also stores the collective memory

of the species, especially the Na'vi, from generation to generation.

Figure 4. The Spirit Tree in the Ancestral Bay.

Ancestral spirits can provide access to memories relevant to a Na'vi's experiences or curiosities. Upon closer examination, ancestral spirits function and operate similarly to DNA, carrying genetic information from a cell's life cycle that is nearly identical, or even identical, to the genetic information of its predecessor, but only partially expressed. This is reinforced by statements Direktorat Jendral Kesehatan Lanjutan (2023) explaining that not all genes in DNA are expressed simultaneously. Cells will only activate (express) some genes that are needed, while others are "shut down" or deactivated. Therefore, ancestral spirits also represent ancestors, which in principle 4B of marine literacy explains that the ancestors of life are thought to have lived in the sea.

Both ancestral spirits and other living beings on Pandora can interact through a physical connection between neural antennae, or Tsaheylu (Figure 5). Connotatively, this represents an "organic technology" based on trust. In a real-world context, this is similar to the relationship between male and female anglerfish, which physically and physiologically unite with each other in a way that is not simply mating, but serves to perpetuate the species by combining the male's lifespan with the female's (Isakov, 2022). The uniqueness of this relationship also represents the principle of the 5D concept of ocean literacy, namely that the ocean provides many unique examples of important relationships between organisms that do not occur on land.

Figure 5. Nerve connection (Tsaheylu).

Then for Figure 6 demonstrates that the sea plays a vital role in life through the process of returning matter, depicted visually as Neteyam's body is returned to the embrace of Aywa (the controller of Pandora's ecosystem). This is relevant to the concept of biogeochemical cycles, particularly the carbon-oxygen cycle, which encompasses phenomena such as photosynthesis, which produces oxygen and sugar from carbon dioxide. Sugar is then used as a raw material for respiration, which uses oxygen to break down sugar back into carbon dioxide (Hagler et al., 2024). Semiotically, this scene visualizes the sea as a "womb" that receives biological material back to be recycled into nutrients for new life. The success of this visualization makes the abstract concept of decomposition and energy flow in the biogeochemical cycle in concept code 2D more emotional; that death in the sea is not the end, but a form of material contribution back into the eternal ocean circulation system. Therefore, based on the analysis of key scenes with ecological & biological themes, a value can be drawn that the sea provides

vital components, mechanisms, unique ecosystem that support the running of life on Earth.

Figure 6. Death of Neteyam

OLC. Socio-environmental and Human Impacts Key Scenes

This section highlights the contrast between the harmony of marine life and destructive human intervention. Semiotic analysis reveals the conflict of beliefs between the Metkayina tribe and the sky people or humans in the movie Avatar: The Way of Water. The Metkayina tribe is depicted as an ideal representation of the 6C concept, where the sea is an important element of their cultural heritage and identity. Denotatively, this is seen in the scenes in Figure 7, Figure 8, and Figure 9 where the Na'vi do not accept that an organism named Tulkun is being hunted by humans, reinforced by the expression of Ronal in Figure 8, also narrative "Humans do not care about the great balance" in Figure 9. Connotatively, the great balance refers to the principle of Na'vi identity which similar to "Natural Harmony". Natural harmony is a concept that proposes the integration of ecological, social, and economic aspects in every management policy and practice (Fatristya & Sjah, 2025).

Meanwhile, humans tend to emphasize rapid economic development, making it difficult to implement an understanding of natural harmony. This is clarified by the United Nations (2021) which states that natural resource management policies often prioritize rapid economic growth without considering the long-term impact on the environment. This is supported by sociological data from Dulvy et al. (2021) which states that overfishing driven by the commodification of marine wildlife has resulted in 37.5% of the world's shark and ray species being threatened with extinction. Ironically, this global exploitation crisis continues to meet market demand, with 96.6% of these threatened species ending up as human food products and raw materials for the cosmetics and pharmaceutical industries.

Figure 7. Hunting of Tulkun.

Ronald's explanation of Tulkun's extremely long reproductive cycle reinforces the narrative of the devastating impact of this exploitation (Figure 8). This relates to the ecological theory of how living things continue their offspring, which consists of two types of strategies: k-strategists and r-strategists. Zheng et al. (2024) outline the differences between the two strategies in general. R-strategists are defense mechanisms that maximize population growth rates, usually carried out when resource conditions are abundant. Meanwhile, k-strategists are defense mechanisms that maximize competitive ability in the environment when resources are limited. Ailatat et al. (2025) added the impact of these strategies on organism characteristics. Organisms with k-strategists tend to have slow reproductive cycles but larger biomass sizes than r-strategists. Because resources are often exploited by uncontrolled human activities, population balance will also be affected and even cause extinction. This is clear evidence of the misuse of marine resources, which aligns with Principle 6D (human influence on resource management). Importantly, this scene also reinforces the 6G Principle: everyone is responsible

for preserving the ocean's ecology because it reviews principle 1H that marine resources are limited and vulnerable to extinction if the rate of human technological extraction exceeds the natural regeneration capacity of these species.

Figure 8. Fraternity between Na'vi and Tulkun.

Jake Sully's expression in Figure 9 is semiotically a cultural code that refers to modern ecological principles, while also functioning as a statement that not only provides information but also makes a moral judgment on human behavior that exploits Amrita through destructive means such as the use of sonar and plastic buoys to immobilize Tulkun. This technology is visualized in the scene in Figure 10 as an extension of human senses to interact with previously inaccessible oceans. Even in the real world, only 5% of Earth's oceans have been officially explored, where current unmanned exploration technology is inadequate for marine exploration research, and technology that allows humans to survive underwater for exploration, such as submarines, is urgently needed (Short, 2024).

Figure 9. Metkayina tribes who threatened by tulkun hunters.

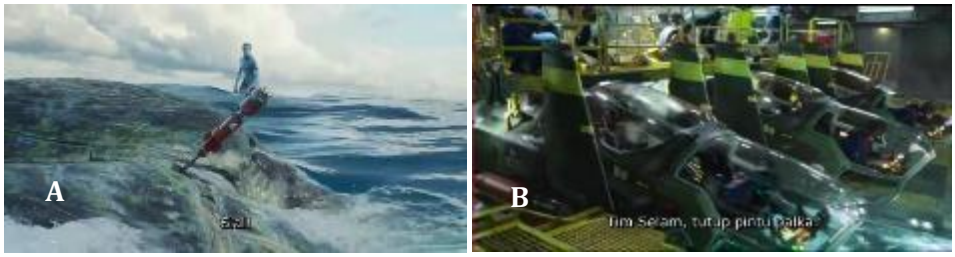

Figure 10. (a) Tracking device; (b) Underwater Ship (Submersibles).

In addition, marine exploration is also depicted through an interdisciplinary work system, where collaboration occurs between various parties in the control room of the Tulkun hunter ship (Figure 11). Ahmed et al. (2025) also explains the definition of interdisciplinarity as the interaction between researchers from different disciplines, includes the continuous transfer of methods and knowledge between academic disciplines during various stages of the entire research process. The narrative "I am Garvin, a marine biologist" denotatively refers to the 7F concept principle that marine exploration is interdisciplinary. Connotatively, the combination of military personnel, technicians, and biologists

shows that understanding the ocean requires scientific data, technical expertise, and communication skills as a cultural bridge. Furthermore, the use of a digital holographic map table in the search process symbolizes the importance of communication technology and modeling in uniting various disciplines for the single purpose of exploration. This proves the claim that the ocean is too complex to be understood from just one perspective. Overall, key scenes themed on socio-environmental and human impacts form the ideology that the increased use of marine resources over the past decades must be accompanied by a deep scientific understanding to ensure future sustainability.

Figure 11. Meeting between Tulkun Hunters and Colonel Quaritz's Military Regiment.

OLA. Physico-chemical System and Geographical Key Scenes

This section highlights the physical and chemical properties that shape the ocean geography of the planet Pandora. A key scene is found in Figure 12, which denotatively depicts the coastal geography of cliffs battered by waves. Connotatively, this geography can be interpreted as the impact of the waves eroding rocks. Figure 13 demonstrates that the morphology of coastal areas is inseparable from the interaction of water, land, and atmospheric forces, which can form wave erosion coast structures in the form of sea caves, stacks, and notches (Cahyati, 2020; Nurkholis et al., 2016). This is relevant to the 2E principle which explains how the physical properties of the sea can shape the coast.

Figure 12. Geographical shape of the ocean.

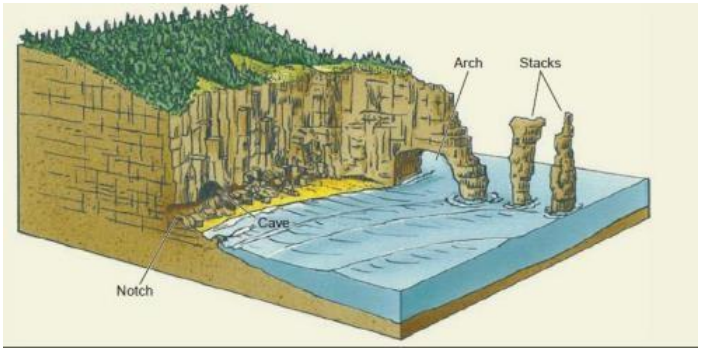

Figure 13. Beach morphology as a result of erotion (*Source: Alar Strahler, Introducing Physical Geography*).

In addition, the condition of the thunderstorm adds to the dramatic effect of the scene in picture 12. Connotatively, interpreting the physicochemical properties where the storm will be stronger over the sea. Furthermore, Arbain (2016) explains that thunderstorms are caused by the process of rising air masses due to convection (heat transfer) from the sea surface into the atmosphere. The rising moist air then experiences cooling and condensation to form massive cumulonimbus clouds that produce lightning rain. And without the barrier of air friction, the wind will move faster. Asfur et al. (2020) added that lightning occurring in the ocean tends to be brighter due to the higher ion content in seawater vapor, resulting in more efficient charge transfer. Overall, the ideology of this theme is formed only by semi-code that presents the natural properties of the observed objects, with the hope that the audience will understand the reasons behind the development of the geological object characters in the movie Avatar: The Way of Water as a basis for science.

CONCLUSION

Through the results of the semiotic analysis conducted on the sample, it can be concluded that the movie Avatar: The Way of Water contains content relevant to the principles of marine literacy. This leads to several ideologies: (1) The ocean provides vital components, mechanisms, and unique ecosystems that support the survival of life on Earth, and therefore needs to be protected; (2) The use of marine resources must be balanced with a deep understanding to ensure future sustainability; (3) Understanding the characteristics of the ocean is essential as a basis for determining a course of action. Therefore, this work has proven to have the potential to be used as an effective educational tool in instilling the seven essential principles of marine literacy in the audience's consciousness.

Therefore, this film has important implications for education as a medium that can be further developed as an instructional tool or learning resource to foster environmental ethics, encourage collective responsibility in protecting the ocean, and introduce the importance of interdisciplinary collaboration in marine exploration.

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