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Research on the Development and Utilization of Marine Education Resources in The Digital Age

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Abstract: This paper focuses on the development and utilization of marine education resources in the digital age. Through multidimensional analysis of the current development status of marine education resources, combined with the unique advantages of digital technologies such as big data, artificial intelligence, and virtual reality, it deeply explores the development principles, innovative models, and efficient utilization strategies of marine education resources. Through the comprehensive use of empirical research methods such as questionnaire surveys and case analysis, a total of 520 questionnaires were distributed to primary and secondary school teachers, university students, and marine education workers in coastal areas. The system revealed that there are practical difficulties in resource development, such as redundant construction, inconsistent standards, low matching degree, and poor interactivity in resource utilization. To address the above issues, solutions are proposed from three aspects: improving development mechanisms, innovating development models, and enhancing utilization efficiency. In terms of development mechanisms, a scientific development system is constructed by establishing unified standards and promoting collaboration among multiple stakeholders; In terms of development mode, personalized resources are developed based on demand orientation, and cutting-edge technologies such as metaverse are integrated to create immersive learning scenarios; In terms of improving utilization efficiency, precise resource delivery and continuous optimization can be achieved by strengthening teacher digital literacy training, building an intelligent recommendation platform, and establishing a dynamic feedback update mechanism. This study aims to provide a feasible theoretical framework and practical path for improving the quality of marine education and promoting the digital transformation of marine education, helping to cultivate high-quality talents that meet the needs of building a maritime power, and enhancing the marine literacy of the entire population.

Keywords: Digital age; Marine education resources; resource development; resource utilization.

1. Introduction

1.1. Research background and significance

As digital technology rapidly advances, the global education sector is undergoing profound changes. Marine education, as a crucial pathway for fostering marine awareness and nurturing marine talent, also faces opportunities for digital transformation. China is a major maritime country, with the marine economys share in the national economy continuously increasing. However, there is a gap between public understanding of the ocean and the needs of building a strong maritime nation. There is an urgent need to address this shortfall through high-quality marine educational resources. The integration of digital technology can break down time and space barriers, enrich educational formats, and significantly enhance the quality of marine education and the overall marine literacy of the population.

1.2. Research status at home and abroad

Abroad, the development of digital marine educational resources started earlier. The National Oceanic and Atmospheric Administration (NOAA) in the United States has developed a rich online platform for marine education, covering multiple fields such as marine science and marine culture; Japan uses virtual reality (VR) technology to create immersive marine education courses. In recent years, related research in China has gradually increased, but most focus on theoretical discussions, with insufficient attention paid to systematic resource development and effective resource utilization, and a lack of empirical analysis.

1.3. Research content and methods

This study primarily explores the principles, development models, current utilization status, and optimization strategies of marine educational resources in the digital age. It employs literature review to outline theoretical foundations; conducts surveys to understand the current usage of marine educational resources; and analyzes successful experiences through case studies to provide a basis for future research.

2. Theoretical Basis of Marine Education Resources Development and Utilization in The Digital Age

2.1. Definition of relevant concepts

Marine educational resources refer to all kinds of materials that serve the dissemination of Marine knowledge, the cultivation of Marine skills and the promotion of Marine awareness, including courses, teaching tools, practical activities, etc. Digital Marine educational resources are the forms of resources that present Marine education content in the form of multimedia and network platforms with the help of digital technology.

2.2. Theoretical basis

Constructivism learning theory: It emphasizes that learners actively construct knowledge. The interactive and situational characteristics of digital resources can better meet the needs of students independent exploration.

Blended learning theory: the combination of online learning and offline learning, digital Marine education resources provide rich online resource support for blended

teaching.

Education informatization theory: promote the digitization and networking of educational resources, promote education equity and quality improvement, and point out the direction for the development and utilization of Marine educational resources.

2.3. The influence of digital technology on the development and utilization of Marine education resources

Digital technologies such as big data, artificial intelligence, and virtual reality can achieve diverse presentations, precise delivery, and personalized customization of marine educational resources. For example, VR technology can simulate the marine ecosystem, allowing students to learn about marine knowledge as if they were there; big data analysis can understand student learning behaviors and optimize strategies for resource development and utilization.

3. Analysis of the Development and Utilization of Marine Education Resources in The Digital Age

3.1. Development status of digital Marine education resources

3.1.1. Development subject and resource type

Currently, the main entities developing digital marine educational resources in our country include universities, research institutions, educational enterprises, and government departments. The resource types cover marine science popularization videos, virtual experiment platforms, online courses, and more. Taking the "Marine Science Virtual Simulation Experiment Teaching Center" developed by Ocean University of China as an example, through virtual experiments, students can simulate practical activities such as marine scientific expeditions and marine ecological monitoring.

In order to more intuitively show the distribution of development subjects and resource types, the following table is made:

Development main body	Main resource types
colleges and universities	Professional courses, virtual experiments, academic materials
scientific research institution	Popular science materials, monitoring data
Educational enterprises	Science popularization animation, interactive software
government sector	Policy publicity and cultural education

3.1.2. Development mode

There are mainly independent development mode (such as universities relying on their own disciplinary advantages to develop characteristic resources), cooperative development mode (government, universities and enterprises jointly develop) and introduction and absorption mode (introduce foreign high-quality Marine education resources). However, there are problems such as repeated construction of resources and non-uniform development standards.

3.2. Utilization status of digital Marine education resources

3.2.1. Investigation design and implementation

In order to understand the current situation of resource utilization, this study distributed questionnaires to teachers, college students and Marine educators in coastal areas, and a total of 520 valid questionnaires were collected. The questionnaire included the frequency of resource use, satisfaction, existing problems and other aspects.

3.2.2. Analysis of investigation results

Frequency of use: 42% of respondents use digital Marine education resources 1-2 times per week, 35% use them 3-4 times, and 23% use them less than once. In order to more intuitively show the frequency of use, the following figure is made:

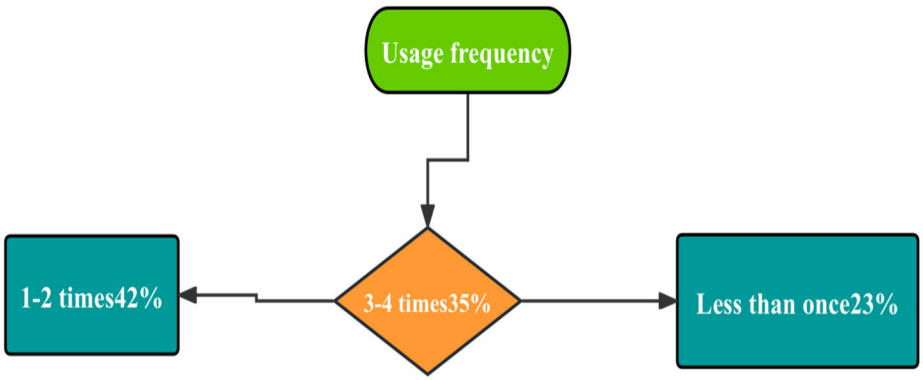

Figure 1. Frequency of use of digital Marine education resources

Satisfaction: The average score of satisfaction with resource quality is 3.2 (full score 5), and the main problems are the lack of practicality, untimely update and poor interactivity. Existing problems: As can be seen from the chart (Figure 2), low matching degree between resources and teaching needs (65%), complex technical operation (58%) and lack of quality resource recommendation (52%) are the main factors affecting resource utilization.

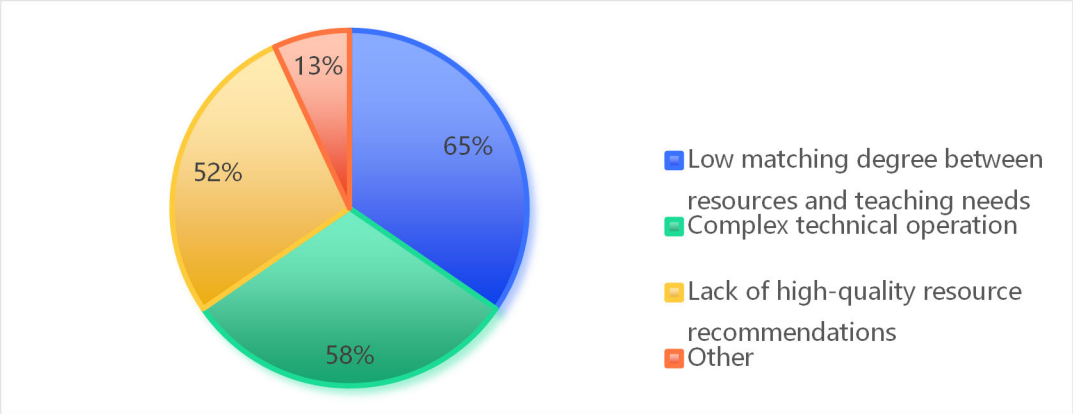

Figure 2. Main factors affecting the utilization of digital Marine education resources

4. Optimization Strategies for the Development and Utilization of Marine Education Resources in the Digital Age

4.1. Improve the resource development mechanism

Unified development standards: Formulate norms for the construction of digital Marine education resources, clarify standards such as resource format, content quality and technical requirements, and avoid duplication of construction. Strengthen cooperation among multiple players: Encourage the government, universities, enterprises and social organizations to participate in resource development and form complementary advantages. For example, the government provides policy support and financial guarantee, universities provide professional knowledge, and enterprises provide technical support.

4.2. Innovative resource development mode

Demand-oriented development: Develop targeted resources through big data analysis of user needs. For example, develop interesting Marine science popularization animation for primary and middle school students, and develop professional Marine research data platform for college students. Integration of new technology development: Use artificial intelligence, metaverse and other technologies to create intelligent and immersive Marine education resources. For example, develop a metaverse ocean museum, allowing users to visit and learn as virtual characters.

4.3. Improve resource utilization efficiency

Strengthen teacher training: carry out training on the use of digital Marine education resources to improve teachers ability to integrate and apply resources. Optimize the resource recommendation mechanism: build an intelligent recommendation platform for Marine education resources, and accurately push resources according to users learning habits and needs. Establish feedback and update mechanism: collect user feedback regularly, update and optimize resource content in time, and improve the practicability and timeliness of resources.

5. Summary

This study systematically explores the development and utilization of marine education resources in the digital age. Through theoretical analysis, empirical research, and case analysis, a relatively complete research results system has been formed. In terms of resource development, the development principles centered on demand-oriented, standardized, and diverse collaboration have been clarified. Research has found that the current development of digital marine education resources in China is characterized by diversification. Universities rely on their disciplinary advantages to build professional curriculum systems, research institutions focus on the transformation of cutting-edge achievements, educational enterprises leverage their technological innovation advantages, and government departments are committed to building public resource platforms. However, there are problems such as duplicate construction and resource homogenization in the development process, and there is a lack of effective communication and collaboration mechanisms between different parties, resulting in structural mismatch between resource supply and actual demand. In terms of development modes, independent development, cooperative development, and introduction and absorption each have their own advantages and disadvantages. In the future, it is necessary to further explore innovative paths that complement each other's strengths and form a benign ecosystem of resource co construction and sharing. At the level of resource utilization, a questionnaire survey found that although digital marine education resources have been applied to a certain extent, the overall utilization efficiency still needs to be improved. In addition, issues such as delayed resource updates and poor interactivity have seriously affected the user experience, reflecting the disconnect between resource development and utilization. In response to the above issues, this study proposes a series of optimization strategies. In terms of improving the development mechanism, it is recommended to establish a unified resource construction standard, clarify content specifications, technical requirements, and evaluation system, and reduce redundant development; At the same time, strengthen government guidance, promote deep cooperation among diverse entities such as universities, enterprises, and research institutions, and integrate advantageous resources from all parties.

In terms of innovative development models, we advocate for the use of big data to analyze user needs and achieve precise resource development; Actively introducing new technologies such as artificial intelligence and metaverse to create intelligent and immersive learning scenarios. In terms of improving resource utilization efficiency, emphasis is placed on strengthening teacher digital literacy training to enhance their ability to integrate and apply resources; Build an intelligent recommendation platform to achieve

personalized resource push; Establish a dynamic feedback mechanism to optimize resource content and functionality in a timely manner based on user feedback. Overall, digital technology has brought unprecedented opportunities for the development of marine education resources, effectively expanding the breadth and depth of marine education by breaking the limitations of time and space, enriching presentation forms. However, there are still many urgent problems to be solved in the current development and utilization of resources. In the future, continuous improvement is needed in development mechanisms, resource quality, and utilization efficiency to promote the digital transformation of marine education resources to a higher level of development. Although this study has achieved certain results, with the rapid iteration of digital technology and the constantly changing demand for marine education, there is still broad room for future research to expand. Firstly, the application of new technologies in the development of marine educational resources deserves further exploration. Taking generative artificial intelligence (AIGC) as an example, its powerful content generation capability can bring revolutionary changes to the development of marine education resources. Future research can explore how to use AIGC technology to automatically generate ocean science popularization animations, virtual experimental scenes, interactive practice questions, and other resources, in order to improve development efficiency and content quality; Meanwhile, by analyzing user learning data, intelligent recommendation and personalized customization of resources can be achieved to meet the needs of different learners. In addition, the integration of technologies such as metaverse and blockchain with ocean education also has great potential. How to build a virtual real integrated ocean education scene, ensure resource copyright protection and secure sharing, will become an important direction for future research. Secondly, strengthening international comparative research is of great significance. Foreign countries started early in the development of digital marine education resources and have accumulated rich experience. NOAA has established a global network of ocean education resources, integrating scientific research data, popular science videos, teaching cases, and other resources to provide one-stop services for users worldwide; Japan has deeply applied VR technology to marine education and developed immersive marine ecological experience courses, effectively enhancing learners' participation and learning outcomes. Future research can systematically review advanced foreign experiences, compare and analyze the differences in resource development policies, operational models, and technological applications among different countries, explore localized development paths based on China's national conditions, and promote the digital construction of China's marine education resources to align with international standards. In addition, future research should also focus on the social benefit assessment of marine educational resources. With the widespread application of resources, their practical effects on enhancing national awareness of the ocean, promoting the development of the ocean economy, and promoting the inheritance of ocean culture need to be scientifically evaluated. A multidimensional evaluation index system can be constructed to quantitatively analyze the impact of resource application on different groups (such as students, teachers, and the general public) through long-term tracking surveys, case analysis, and other methods, providing a basis for resource optimization and policy formulation. At the same time, research also needs to pay attention to the issue of equity in marine education resources, explore how to narrow the digital divide between urban and rural areas and regions, and ensure that high-quality resources benefit more groups. Finally, the sustainable development mechanism for the development and utilization of marine educational resources needs further research. At the level of resource development, it is necessary to explore an operational model that combines marketization and public welfare, attract social capital participation, and ensure long-term investment in resource development; At the level of resource utilization, a multi-party collaborative promotion mechanism should be established to strengthen cooperation with schools, communities, and enterprises, and expand resource coverage. In addition, with the continuous progress of marine science and technology, the content of marine education also needs to be continuously updated. How to establish a dynamic resource update mechanism and maintain the timeliness and progressiveness of resources is also an important issue for future research. In summary, the development and utilization of marine education resources in the digital age is a continuous and dynamic process. Future research needs to keep up with technological trends, base on practical needs, constantly explore and innovate, and provide solid support for promoting the high-quality development of marine education in China.

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