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Blockchain + AI Evidence Storage: Innovation of Sharing and Copyright Protection Mechanism for High-Quality Marine Educational Curriculum Resources

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Abstract: Under the dual background of the in-depth advancement of the maritime power strategy and the comprehensive implementation of the digital education strategy, high-quality marine education curriculum resources are the core carrier for spreading marine culture, cultivating national marine literacy and consolidating the foundation of marine professional talent training. Its digital, inclusive and standardized development has become the core direction of marine education reform. At present, the digital construction of marine education curriculum resources in China has taken initial shape, forming a digital resource system covering all educational stages and multiple fields. However, many deep-seated dilemmas still exist in resource circulation and copyright management. High-quality resources are fragmented and scattered with strict cross-regional, cross-platform and cross-subject sharing barriers, making it difficult to give full play to the efficiency and inclusive value of resources. The copyright confirmation process of digital curriculum resources is cumbersome with ambiguous ownership definition. Piracy, unauthorized tampering, illegal dissemination, commercial profit-making and other infringements occur frequently with strong concealment. Infringement evidence collection is difficult, the right protection cycle is long, and the cost of rights protection remains high, which cannot effectively protect the legitimate rights and interests of original developers. In addition, the multi-party benefit distribution mechanism for resource sharing is missing, resulting in prominent interest imbalance, which seriously dampens the enthusiasm of market entities for resource development and sharing. Blockchain technology has the core characteristics of decentralization, distributed storage, non-tamperability, full traceability and automatic execution of smart contracts, providing underlying trust support for authoritative right confirmation, credible evidence storage and safe circulation of digital resources. Relying on in-depth algorithm learning, intelligent content recognition, big data comparison, full-network real-time monitoring and electronic evidence fixation, AI technology provides an efficient implementation scheme for digital copyright efficient monitoring, rapid evidence collection and accurate traceability. The in-depth integration and complementary advantages of the two precisely meet the dual core needs of efficient sharing and full-process copyright protection of marine education curriculum resources, providing a new technical path to solve industrial development pain points. Based on the whole-process scenarios of the construction, dissemination, application and management of high-quality marine education curriculum resources, this paper systematically sorts out the practical dilemmas and core pain points of current industrial development, deeply analyzes the adaptability logic, technical advantages and theoretical value of the integrated application of blockchain and AI evidence storage technology in the marine education field. It constructs an innovative mechanism integrating automatic right confirmation for resource creation, cross-domain secure sharing and circulation, full-process infringement monitoring and traceability, multi-party fair benefit distribution, and full-life-cycle copyright management. At the same time, systematic and implementable implementation paths are proposed from six dimensions: policy system, platform construction, technological research and development, talent training, multi-party collaboration and pilot promotion, with demonstration on practical application feasibility. The research aims to break the "information island" of marine education resources, balance resource sharing efficiency and copyright protection, resolve the dual contradictions between resource circulation and rights protection, and improve the digital development ecosystem of marine education. It provides solid theoretical support and practical guidelines for promoting the universal sharing of high-quality marine education resources, protecting intellectual property rights of original creators, and facilitating the implementation of the maritime power strategy.

Keywords: Blockchain; AI Evidence Storage; Marine Education; High-quality Curriculum Resources; Copyright Protection; Resource Sharing; Mechanism Innovation; Educational Digitalization.

1. Introduction

1.1. Research Background

The construction of a maritime power is a major national strategy related to the overall national development. Improving national marine awareness, cultivating high-quality marine professional talents, and inheriting and carrying forward marine culture are the basic projects for promoting the implementation of the maritime power strategy, and marine education is the core grasp to achieve this goal. In recent years, the state has successively issued a series of policy documents such as the Guiding Opinions on Strengthening Marine Education and the Action Plan for Digital Transformation of Education, clearly proposing to strengthen the construction of marine education resources, promote the digital development of marine education, and expand the coverage of high-quality marine education resources, pointing out the direction for the development of marine education.

Driven by policies and the digital transformation of education, the construction of marine education curriculum resources in China has entered a period of rapid development. Universities, scientific research institutes, marine science popularization venues, local education departments, private

educational institutions, industry enterprises and other multiple entities have participated in resource development, forming a full-stage system including preschool enlightenment, basic education, higher education, vocational education and social science popularization. It covers multiple fields such as marine science, marine ecological environment protection, marine rights and security, marine economic development, marine history and culture, and marine disaster prevention and mitigation. Diversified resources such as courseware, lesson plans, teaching videos, training materials, popular science picture books and online courses have been continuously enriched, providing important support for different groups to acquire marine knowledge and improve marine literacy.

With the popularization of digital technology and the convenience of network communication, the digital and networked communication of marine education curriculum resources has become the mainstream trend. However, the deep-seated contradictions in resource management and copyright protection have become the core bottlenecks restricting the high-quality development of the industry. From the perspective of resource sharing, marine education resource development entities are diverse and scattered, lacking unified resource construction standards, collaborative sharing mechanisms and overall management platforms. The storage, classification, coding and formats of resources are different, data are incompatible and difficult to communicate, and a large number of high-quality resources are closed within various development entities, forming numerous independent "information islands". It is extremely difficult for cross-regional, cross-departmental and cross-platform resource integration and circulation. At the same time, resource sharing lacks clear access rules, authorization standards and incentive mechanisms. Most high-quality resources are only for internal use with high external sharing thresholds and narrow channels. Grassroots educational institutions and the public have high costs to obtain high-quality marine education resources, the scale and intensive effect of resources cannot be exerted, and the inclusive value of high-quality educational resources is difficult to land truly.From the perspective of copyright protection, digital marine education curriculum resources have the characteristics of easy replication, easy dissemination, easy tampering and no physical form. The traditional copyright protection model has been completely unable to adapt to the development needs of the digital era. First, the traditional copyright registration adopts offline manual review mode with cumbersome procedures, a cycle of several months and service fees. It is impossible to realize rapid and batch right confirmation for massive, fragmented and rapidly updated marine education curriculum resources, and a large number of original resources are not protected by copyright due to high right confirmation costs. Second, in the process of network communication, digital resources are easily deleted, spliced, tampered and repackaged at will, the boundary between original content and infringing derivative content is blurred, and there is no unique, authoritative and non-tamperable identity identifier, making it difficult to define copyright ownership accurately. Third, network infringements are decentralized, concealed and rapidly spreading. Piracy reproduction, unauthorized reprinting, illegal sales, malicious tampering and other infringements emerge in endlessly. Traditional manual monitoring cannot achieve full-network full coverage inspection, and most infringements are difficult to detect in a timely manner. Fourth, infringement evidence is mostly digital electronic data, which is easy to be deleted, tampered and destroyed. The evidence collection process is complex and professional. Original creators need to invest a lot of time, energy and funds to collect evidence, with insufficient legal effect of evidence, low success rate of rights protection, forming an industry phenomenon of easy infringement, difficult rights protection and loss of rights protection.

In addition, the sharing of marine education curriculum resources involves multiple parties such as developers, disseminators, users, operation platforms and regulatory departments, with obvious differences in rights and interests demands. However, there is no fair, transparent, traceable and automated benefit distribution mechanism in the industry. The public welfare value and economic benefits generated by resource sharing cannot be reasonably returned to original developers, leading to prominent imbalance of multi-party interests. The above problems are intertwined, which not only seriously restricts the circulation and utilization efficiency of high-quality marine education resources, but also greatly dampens the enthusiasm of all sectors of society for the development and innovation of marine education resources, hindering the digital, standardized and sustainable development of marine education.

In this context, exploring an innovative mechanism adapted to the sharing and copyright protection of marine education curriculum resources in the digital era has become an urgent major issue in the field of marine education. As the core technologies of the digital economy, blockchain and artificial intelligence have shown strong application potential in the fields of intellectual property protection, educational informatization and digital resource management. The decentralized trust system built by blockchain technology can realize permanent evidence storage, non-tampering and full traceability of digital resources, fundamentally solving the problems of difficult right confirmation, difficult evidence collection and lack of trust in digital resources. AI evidence storage technology can realize rapid identification of resource originality, real-time early warning of infringements and automatic solidification of electronic evidence, greatly improving the efficiency of copyright protection. The in-depth integration of the two into the field of marine education to build a technology-enabled resource sharing and copyright protection mechanism can not only break resource sharing barriers, but also build a solid line of copyright protection, which is of important practical significance for promoting the high-quality development of marine education.[1]

1.2. Research Status

1.2.1. Foreign Research Status

Foreign marine education started early and has rich experience in educational resource construction and digital management. Relevant researches mainly focus on marine education resource integration, digital platform construction and legalization of copyright protection. In terms of resource sharing, foreign scholars focus on building an integrated marine education resource platform, promoting collaborative cooperation among the government, universities, scientific research institutions and social institutions, establishing unified resource construction standards and sharing mechanisms to realize global circulation of high-quality resources. In terms of copyright protection, foreign countries rely on a sound intellectual property legal system to strengthen law enforcement of digital copyright. At the same

time, they actively explore the application of digital technology in copyright protection. Researches on the application of blockchain and artificial intelligence technology in digital copyright management are relatively mature, forming a relatively complete copyright protection system combining technical protection and legal guarantee. However, foreign researches are mostly based on their own national education systems and legal systems, which are different from China's marine education development national conditions, resource construction status and copyright management environment, and relevant achievements cannot be directly applied.

1.2.2. Domestic Research Status

Domestic academic circles have carried out a large number of researches on marine education, educational resource sharing, digital copyright protection, blockchain and AI technology application, laying a solid theoretical foundation for this paper. In the field of marine education, existing achievements mainly focus on the construction of marine education curriculum system, innovation of teaching modes, practical paths of popular science education and optimization of talent training modes. Special researches on the operation and management of digital marine education curriculum resources, cross-domain sharing mechanisms and copyright protection systems are relatively weak, especially lacking systematic and targeted exploration on the integrated application of digital technologies, which cannot respond to the practical demands of the development of marine education resources in the digital era.

In terms of educational resource sharing and copyright protection, scholars generally recognize the contradiction between sharing and protection of digital educational resources, analyze the current pain points and dilemmas of copyright protection, and put forward countermeasures and suggestions such as improving legal systems, strengthening industry self-regulation and intensifying regulatory law enforcement. At the same time, researches are carried out on the application of blockchain, artificial intelligence, big data and other technologies in copyright protection of educational resources, demonstrating the feasibility and application paths of technology-enabled right confirmation, monitoring and rights protection. However, existing researches mostly focus on the general fields of basic education and higher education, with few special researches on the segmented professional field of marine education, failing to carry out differentiated and scenario-based mechanism design combined with the professionalism, public welfare, diversification and multi-agent development of marine education resources.

In terms of integrated technology application, most existing studies separately discuss the application of blockchain in digital copyright evidence storage and resource sharing, or the application of AI technology in infringement monitoring and content identification. The collaborative logic, integration mode and full-process landing path of blockchain and AI evidence storage technology are not deeply studied, and there is no complete and systematic resource sharing and copyright protection mechanism adapted to the whole scenario of marine education. In summary, there is no domestic targeted system for the protection and sharing of marine education curriculum resources based on blockchain + AI evidence storage. This paper takes this as the entry point for research, with strong theoretical innovation and practical complementarity.

1.3. Research Significance

1.3.1. Theoretical Significance

First, enrich the theoretical system of digital construction of marine education. This paper deeply integrates blockchain, AI evidence storage technology with marine education and intellectual property protection theories, focusing on the core issues of sharing and copyright protection of marine education curriculum resources, carrying out targeted mechanism innovation research, expanding the dimension and boundary of marine education research, and making up for the deficiencies of existing researches on digital management and copyright protection of marine education resources. Second, improve the applied theories of digital technology enabling the education field. This paper systematically analyzes the adaptability logic, technical value and operation mechanism of the integrated application of blockchain and AI evidence storage technology in the segmented field of marine education, enriching the theoretical research on the integrated application of digital technology and education, and providing new perspectives and theoretical references for subsequent academic researches in related fields. Third, construct the collaborative development theory of educational resource sharing and copyright protection. Based on the two-way balance goal of resource sharing and copyright protection, this paper proposes a collaborative development mechanism, breaking the single limitation of **emphasizing sharing over protection** or **emphasizing protection over sharing** in traditional researches, and improving the collaborative development theoretical system of educational resource sharing and copyright protection.

1.3.2. Practical Significance

First, solve the practical dilemmas of the development of marine education resources. By constructing the innovative mechanism of blockchain + AI evidence storage, effectively solve the current pain points of difficult right confirmation, difficult sharing, difficult rights protection and difficult distribution of marine education curriculum resources, promote the efficient circulation of high-quality resources, improve resource utilization efficiency, and realize two-way win-win of resource sharing and copyright protection. Second, protect the legitimate rights and interests of marine education original creators. Relying on technical advantages to realize full-process protection of copyright, reduce the cost of rights protection, improve the efficiency of rights protection, stimulate the enthusiasm of original developers for the development and innovation of marine education resources, and promote the high-quality and sustainable construction of marine education resources. Third, promote the inclusive development of marine education. Break resource circulation barriers, expand the coverage of high-quality marine education resources, allow grassroots educational institutions and the public to obtain high-quality resources more conveniently, and help improve national marine literacy and cultivate marine professional talents. Fourth, provide practical guidelines for industrial practice. The proposed mechanism and implementation paths are both theoretical and practical, which can provide direct decision-making references and action plans for the government, education departments, copyright management departments, resource development entities and platform operators, and help the digital, standardized and legalized development of marine education.[2]

1.4. Research Ideas and Methods

1.4.1. Research Ideas

Taking the core logic of **raising problems-analyzing problems-solving problems**, taking the practical pain points of sharing and copyright protection of high-quality marine education curriculum resources as the entry point, this paper first combs the research background, domestic and foreign research status, research significance and innovation points. Secondly, systematically analyze the current development status, core pain points and causes of sharing and copyright protection of marine education curriculum resources. Thirdly, deeply analyze the core characteristics, application advantages of blockchain + AI evidence storage technology and its adaptability logic in the field of marine education. Then, build an all-round and full-process innovative mechanism for sharing and copyright protection of marine education resources. Finally, propose systematic implementation paths to ensure mechanism landing and demonstrate feasibility, forming a complete research system ultimately.

1.4.2. Research Methods

Literature Research Method: Through CNKI, Wanfang, Weipu and other academic databases, as well as official government websites, industry reports and policy documents, systematically sort out research achievements, policy systems and industry data in the fields of marine education, resource sharing, copyright protection, blockchain and AI evidence storage, providing solid theoretical support and policy basis for this research.

Interdisciplinary Research Method: Integrate pedagogy, marine science, intellectual property law, computer science, economics and other multi-disciplinary theories and methods, break the limitations of single-discipline research, and carry out innovative research on sharing and copyright protection mechanisms of marine education resources from multiple dimensions and perspectives to improve the systematicness and comprehensiveness of the research.

System Analysis Method: Regard the sharing and copyright protection of high-quality marine education curriculum resources as a complete system, analyze the internal logical connection among various subjects, links and elements in the system, analyze the operational pain points and contradictions of the system, and build an overall and collaborative innovative mechanism to ensure the logical integrity and completeness of the research.

Case Analysis Method: Combine mature application cases of blockchain, AI evidence storage technology in digital copyright protection and educational resource management, summarize practical experience, demonstrate the feasibility of integrated technology application in the field of marine education, and provide practical references for mechanism construction and path optimization.

1.5. Research Innovation Points

First, **field innovation**: Focus on the segmented professional field of marine education, break the limitations of existing general educational resource researches, carry out targeted and differentiated mechanism design combined with the actual scenarios and professional characteristics of marine education resource construction, management and application, filling the domestic research blank of copyright protection and sharing mechanism of digital marine education curriculum resources.

Second, **technical innovation**: Break the limitation of single technology application, deeply integrate the dual technical advantages of blockchain trust support and AI efficient monitoring, build a full-process closed-loop mechanism of right confirmation and evidence storage-sharing circulation-monitoring and traceability-benefit distribution-full life cycle management, realize accurate adaptation between technology and marine education scenarios, and improve the scientificity and effectiveness of the mechanism.[3]

Third, **mechanism innovation**: Based on the two-way balance goal of resource sharing and copyright protection, build an innovative mechanism with multi-party coordination, clear rights and responsibilities, high fairness and easy implementation, taking into account the public welfare attributes of marine education resources and the economic rights and interests of original creators, breaking the contradiction between sharing and protection in traditional modes, and realizing the benign cycle of industrial sustainable development.

Fourth, **practical innovation**: Combined with China's policy system, industry status and technology development level, propose systematic implementation paths from six dimensions, with both theoretical height and practical operability, which can be directly applied to the management practice of marine education resources, providing practical and feasible solutions for industrial development.

2. Current Situation and Problems of Sharing and Copyright Protection of High-Quality Marine Educational Curriculum Resources

2.1. Current Situation of Construction and Development of High-Quality Marine Educational Curriculum Resources

In recent years, driven by national policies and the digital transformation of education, remarkable achievements have been made in the construction of high-quality marine education curriculum resources in China, with continuous expansion of resource scale, increasingly rich types and expanding coverage, gradually forming a diversified, digital and multi-level resource system. From the perspective of resource development subjects, a diversified development pattern of government guidance, leading by universities and scientific research institutes, and extensive participation of social institutions has been formed. Universities focus on the development of marine professional curriculum resources, scientific research institutes focus on the supply of professional popular science and academic resources, marine museums and popular science institutions create public popular science resources, and private educational institutions supplement market-oriented and personalized resources. All subjects work together to enrich the supply of marine education resources.

From the perspective of resource types and contents, it includes two categories: digitalization of paper resources and original digital resources, specifically including teaching courseware, lesson plans, teaching videos, training simulation materials, popular science animations, online high-quality courses, marine reading materials, question banks and teaching cases. The contents cover marine scientific knowledge, marine ecological protection, marine rights and

security, marine economic industry, marine history and culture, marine disaster prevention and reduction and other fields, meeting the diversified learning needs of preschool education, basic education, higher education, vocational education and the public. From the perspective of digitalization of resources, most high-quality marine education curriculum resources have completed digital transformation, various online resource platforms and educational apps are gradually popularized, making resource communication and use more convenient, laying a solid foundation for the popularization and development of marine education.

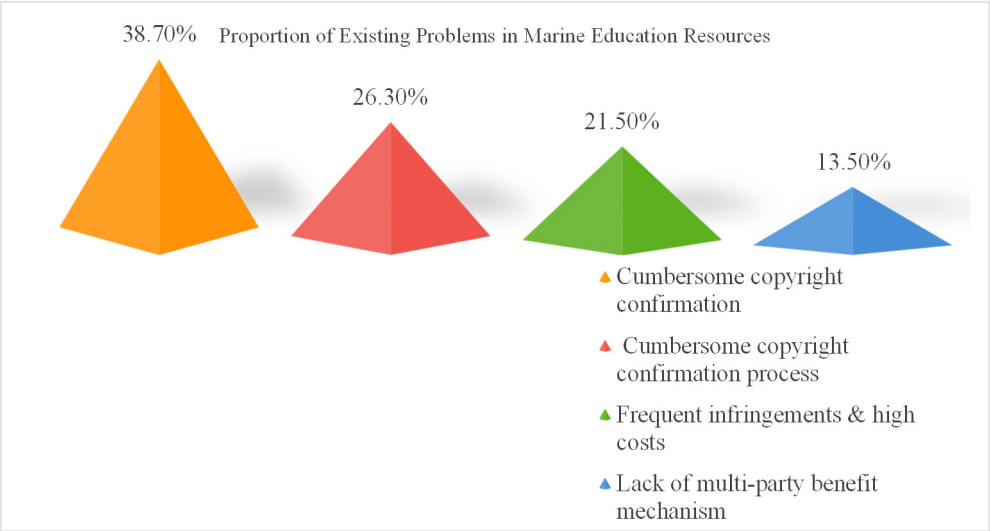


Figure 1. Proportion of Existing Problems of High-quality Marine Education Curriculum Resources

At the same time, the state and local governments have successively built various marine education resource platforms and public service platforms for educational digitalization to promote online sharing of marine education resources, and resource circulation channels have been gradually expanded. On the whole, the construction of marine education curriculum resources in China is still in the key stage of transformation from scale expansion to quality improvement and standardized management. The problems of emphasizing development over management, emphasizing quantity over quality still exist, the system of resource sharing and copyright management is not perfect, and many practical problems restrict the high-quality development of the industry.

2.2. Core Existing Problems of Sharing and Copyright Protection of High-Quality Marine Educational Curriculum Resources

2.2.1. Severe Fragmentation of Resource Distribution and Lack of Global Efficient Sharing Mechanism

First, inconsistent resource standards leading to great integration difficulties. At present, there is no unified national standard for the development, classification, coding, storage and access of marine education curriculum resources in China. Each development subject carries out resource construction according to its own standards, with different resource formats, classification systems, quality specifications and data interfaces. Resource data are incompatible and difficult to communicate. A large number of high-quality resources are scattered in the internal systems of various subjects, forming independent **information islands**, making it extremely difficult for cross-subject, cross-regional and cross-platform resource integration and overall management.Second, imperfect collaborative sharing mechanism leading to strict circulation barriers. There is no effective collaborative cooperation, resource sharing and benefit distribution mechanism among marine education resource development subjects. Due to copyright concerns, resource monopoly and management costs, various subjects have low willingness to share external resources, low openness of resources and high sharing thresholds, making it difficult for high-quality resources to achieve global free circulation. At the same time, there is no national and professional integrated sharing platform for marine education resources. Existing platforms are mostly regional and single-subject operation, with narrow resource coverage and limited scale, unable to meet the needs of global sharing.[4]

Third, low resource utilization efficiency and insufficient inclusive value. The fragmentation and closed circulation of high-quality resources make it difficult for grassroots schools, remote areas and the public to obtain high-quality marine education resources conveniently, with low matching degree between resource supply and demand. A large number of high-quality resources are in a dormant state with extremely low utilization efficiency. The public welfare attributes and inclusive value of marine education resources cannot be fully exerted, which is contrary to the goals of educational equity and national marine education.

2.2.2. Cumbersome Copyright Confirmation Process and Difficult Ownership Definition

First, poor adaptability of traditional right confirmation mode. Digital marine education curriculum resources have the characteristics of massive, fragmentation and rapid update, while the traditional copyright registration mode has cumbersome procedures, long cycle and high cost, requiring a large number of paper materials and multiple rounds of manual review. It is impossible to realize rapid and batch right confirmation of digital resources. A large number of original resources are not registered for copyright due to high right confirmation costs and complex processes, in an unprotected state.

Second, vague definition of copyright ownership. Digital marine education curriculum resources are easy to copy, tamper and spread, and multi-subject cooperative development is common. In the process of communication,

resources are easily modified, spliced and repackaged at will, with blurred boundaries between original and infringing derived resources. There is no authoritative, unique and non-tamperable ownership certificate, making it difficult to accurately define copyright ownership and frequent copyright disputes.

Third, insufficient evidence storage effect, unable to be used as rights protection basis. Traditional resource creation and communication records are mostly stored in the form of ordinary electronic data, easy to be tampered and deleted, without judicial legal effect, unable to be used as effective evidence for copyright confirmation and rights protection, further increasing the difficulty of ownership definition and rights protection.

2.2.3. Frequent and Concealed Infringements and High Cost of Evidence Collection and Rights Protection

First, diverse and repeated online infringements. Relying on rapid network communication, digital marine education curriculum resources face endless infringements such as piracy reproduction, free reprinting, illegal sales, malicious tampering and deletion of copyright information for commercial profit. Infringement subjects are scattered with concealed means, and infringements spread rapidly, causing serious damage to the rights and interests of original creators. Second, difficult infringement monitoring and delayed discovery. Traditional copyright protection relies on manual investigation and complaint reporting, with limited monitoring scope and low efficiency, unable to achieve full-network, all-weather and full-coverage inspection. A large number of infringements cannot be found in a timely manner, and losses are difficult to recover after infringements cause widespread impact. Third, difficult evidence collection and unbalanced cost-benefit. Infringement evidence is mostly digital electronic data, easy to be destroyed and tampered. The evidence collection process is complex and professional. Original creators need to invest a lot of time, energy and funds to collect evidence, with insufficient legal effect of evidence. The rights protection cycle is as long as several months or even years, with low success rate of rights protection. The cost of rights protection is far higher than the income from infringement, leading original creators to be unwilling and dare not protect rights.

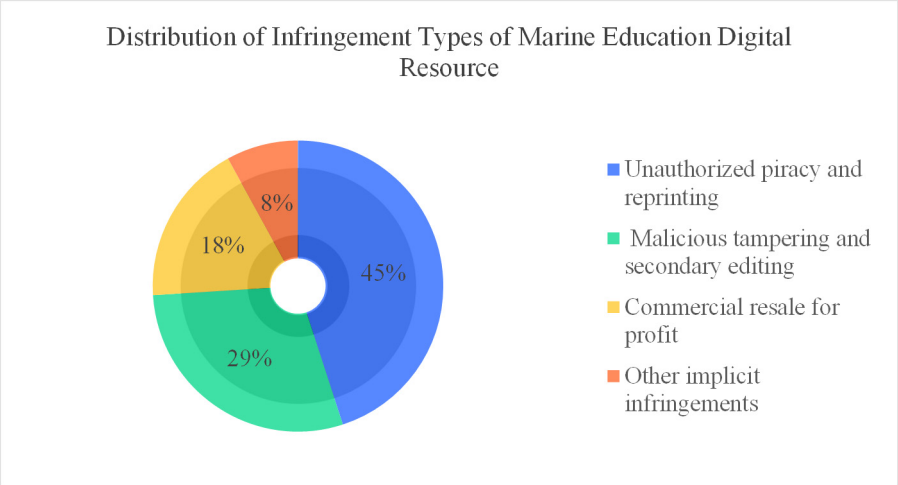


Figure 2. Distribution of Infringement Types of Marine Education Digital Resources

2.2.4. Lack of Benefit Distribution Mechanism and Serious Imbalance of Multi-Party Interests

The sharing of marine education curriculum resources involves multiple subjects such as original developers, resource disseminators, platform operators and supervisors, with different rights and interests demands. However, there is no fair, transparent, automated and traceable benefit distribution mechanism in the industry at present. On the one hand, as the main body of resource creation, original developers cannot get reasonable returns for their intellectual achievements and labor efforts. Most of the benefits generated by resource sharing are occupied by platforms and disseminators, and the rights and interests of original creators are seriously ignored. On the other hand, for resources jointly developed and disseminated by multiple subjects, there is no clear ownership division standard and distribution rule, leading to frequent interest disputes, greatly dampening the enthusiasm of original creators for developing high-quality resources and participating in resource sharing.

2.2.5. Imperfect Supervision System and Weak Industrial Copyright Protection Awareness

First, imperfect collaborative supervision mechanism. The copyright protection of marine education resources involves multiple departments such as education, copyright, cyberspace administration, public security and justice, with unclear division of regulatory responsibilities, lack of collaborative supervision, joint law enforcement and information sharing mechanisms, unable to form regulatory synergy, and infringements cannot be effectively cracked down.Second, lack of industrial norms and self-regulation mechanism. Special industrial norms and self-regulation guidelines for copyright protection of digital marine education resources have not been improved, the guiding role of industrial associations is insufficient, some market entities have weak copyright protection awareness, and piracy and illegal use cannot be effectively restricted.Third, insufficient social copyright awareness. Some educators, learners and the public have weak copyright protection awareness, believing that marine education resources belong to public welfare resources and can be used and spread at will, lacking cognition and resistance to infringements, objectively fueling the spread of infringements.[5]

2.3. Cause Analysis of Problems in Sharing and Copyright Protection of Marine Education Resources

First, insufficient top-level overall planning and imperfect institutional system. The national overall planning for the

construction, sharing and copyright protection of digital marine education resources is not detailed enough, unified industrial standards, management systems and supporting legal detailed rules have not been improved, lacking targeted and operable policy and institutional support, leading to no rules to follow in resource construction and copyright management.Second, lack of technical support system. The traditional management mode relies on manual operation, without introducing advanced digital technology empowerment, lacking efficient technical means for right confirmation and evidence storage, infringement monitoring and traceability rights protection, unable to adapt to the management needs of digital resources, with low efficiency of right confirmation, monitoring and rights protection.

Third, insufficient multi-party collaborative cooperation. There is no effective collaboration among the government, enterprises, universities, institutions and platforms, and the mechanism of joint construction, sharing and co-governance of resources has not been formed, working separately and operating dispersedly, unable to form industrial development synergy.Fourth, lack of incentive and restraint mechanisms. There is no effective incentive for original developers and rigid constraints on infringements, with unbalanced interest distribution, unable to mobilize the enthusiasm of subjects for sharing and copyright protection, and low cost of infringements.Fifth, insufficient professional talent support. There is a shortage of compound talents with marine education professional knowledge, copyright management ability and digital technology application ability, insufficient professional literacy of industrial practitioners, unable to support high-quality resource construction and standardized copyright management.

3. Core Characteristics of Blockchain + AI Evidence Storage Technology and Adaptability Analysis in Marine Education Field

3.1. Core Characteristics of Blockchain Technology and Its Application Advantages in Marine Education Field

Blockchain is a decentralized distributed ledger database, realizing distributed data storage, point-to-point transmission, non-tampering and full traceability through encrypted hash algorithms, consensus mechanisms and timestamp technology. Its core characteristics are highly consistent with the needs of sharing and copyright protection of marine education curriculum resources, with significant application advantages.[6]

3.1.1. Non-tamperable and Credible Evidence Storage

Blockchain uses encrypted hash algorithms to encrypt data. Each data block contains the hash value of the previous block, and all data are synchronously stored in multiple distributed nodes. Once data are uploaded to the chain, no single node can tamper, delete or forge it alone, permanently ensuring the authenticity and integrity of data. Applied to marine education curriculum resources, it can permanently store original resource information, copyright ownership, creation time, modification records, communication tracks and other data on the chain, forming authoritative and non-tamperable copyright evidence, completely solving the problems of difficult right confirmation, evidence storage and collection.

3.1.2. Decentralization and Barrier Breaking

The decentralized operation mode of blockchain does not require the control of third-party intermediaries. All participating subjects access the network as equal nodes to realize point-to-point data transmission, synchronous sharing and joint supervision, breaking the monopoly and closed management of resources by a single subject. Applied to marine education resource sharing, it can effectively integrate scattered high-quality resources, break information barriers among subjects, solve the problems of resource fragmentation and information islands, and realize global efficient circulation of resources.

3.1.3. Automatic Execution of Smart Contracts

Smart contracts are programmable and automatically executed contract clauses preset on the blockchain. When preset conditions are met, the contract automatically executes corresponding operations without manual intervention, with full transparency, irreversibility and fairness. Applied to marine education resource management, it can preset resource authorization rules, use permissions, benefit distribution ratios and payment standards, automatically complete resource authorization, income settlement and benefit distribution, realize process automation and management intelligence, avoid unfair disputes caused by manual intervention, and improve operational efficiency.[7]

3.1.4. Full Traceability and Clear Responsibility

Blockchain can completely record the whole life cycle track of digital resources from creation, uploading, modification, communication, authorization to use. All records can be checked, traced and verified, accurately locating every link of resource circulation. Applied to marine education copyright protection, it can quickly trace the source of infringement, define infringing responsible subjects, and provide accurate and effective basis for infringement rights protection and dispute handling.

3.1.5. Safe, Credible and Stable

Blockchain adopts distributed storage and encryption technology. Data are stored in multiple nodes synchronously. Single node failure and damage will not affect the overall data safety, with strong anti-attack ability and high data stability. It can effectively ensure the safety of marine education curriculum resource data and copyright information, avoiding resource loss, data leakage and information tampering.

3.2. Core Characteristics of AI Evidence Storage Technology and Its Application Advantages in Marine Education Field

Relying on deep learning, big data analysis, intelligent image recognition, text comparison, audio and video feature extraction algorithms, AI evidence storage technology realizes intelligent identification, monitoring, evidence collection and solidification of digital resources, forming efficient complementarity with blockchain technology, providing efficient support for sharing and copyright protection of marine education resources.

3.2.1. Intelligent Content Recognition and Generation of Unique Fingerprints

Through deep algorithm learning, AI technology can fully extract features of various digital resources such as marine education texts, videos, audios, courseware and pictures, generate exclusive, unique and non-replicable content fingerprints for each original resource, realize rapid identification and accurate distinction of resource originality,

prevent infringing resources from going online from the source, and ensure resource originality.

3.2.2. Full-Network Real-Time Monitoring and Timely Infringement Early Warning

AI big data monitoring technology can realize all-weather, automatic and full-coverage inspection of various network channels such as websites, educational platforms, social media, short video platforms and network disks, grab network data in real time, compare with original resource content fingerprints quickly and accurately, identify infringements such as piracy, unauthorized communication and commercial sales, send early warnings to original creators and platforms for the first time, realizing early discovery and early termination of infringements.[8]

3.2.3. Solidification of Electronic Evidence and Improvement of Rights Protection Efficiency

AI technology can automatically grab and solidify key electronic evidence such as infringing content, infringing links, communication time, access volume and infringing subjects, conduct encrypted solidification processing synchronously, and directly upload to blockchain for evidence storage, forming a complete, legal and non-tamperable evidence chain, simplifying the rights protection and evidence collection process, reducing the cost of rights protection for original creators, and improving the efficiency and success rate of rights protection.

3.2.4. Intelligent Resource Classification and Accurate Matching and Sharing

AI technology can automatically classify, label and intelligently retrieve massive marine education curriculum resources, accurately push adapted resources according to users' school stages, fields and demand preferences, optimize the resource sharing experience, improve the matching degree between resource supply and demand and circulation efficiency, and promote high-quality resources to accurately reach audiences.

3.3. Adaptability of Integrated Application of Blockchain + AI Evidence Storage Technology in Marine Education Field

3.3.1. Collaborative and Complementary Technical Logic

Blockchain mainly solves the problems of trust and evidence storage in digital resource management, providing underlying trust system for authoritative right confirmation, credible evidence storage, safe circulation and fair distribution of marine education resources. AI mainly solves the problems of efficiency and accuracy, providing efficient implementation means for resource identification, infringement monitoring, evidence fixation and efficient sharing. The in-depth integration of the two forms a closed-loop system of trust support + efficient execution, perfectly adapting to the whole-process needs of marine education resource management and making up for the limitations of single technology application.

3.3.2. Highly Consistent Application Scenarios

Marine education curriculum resources are mainly in digital form with unified types, clear application scenarios and clear subjects, convenient for docking with blockchain alliance chains and AI monitoring systems without complex technical transformation. At the same time, marine education has both public welfare and market attributes, needing both efficient resource sharing for public welfare and full copyright protection for original creators, exactly fitting the application goal of equal emphasis on sharing and protection of blockchain + AI evidence storage technology, with strong scenario adaptability.

3.3.3. Strong Practical Landing Feasibility

Blockchain and AI technologies have a large number of mature application cases in the fields of digital copyright protection, educational informatization and public resource management, with gradually improved technical stability, safety and compliance, relevant technical standards, operation modes and legal recognition systems. It can be directly learned and optimized for application in the field of marine education, with low landing difficulty and high promotion feasibility, realizing industrial application quickly.

3.3.4. Meeting Industrial Development Needs

The integrated application of blockchain + AI evidence storage technology can accurately solve all core pain points in current sharing and copyright protection of marine education resources, realize efficient resource sharing and comprehensive copyright protection and fair benefit distribution, which is in line with the digital and inclusive development trend of marine education and the requirements of national intellectual property protection policies, meeting the core needs of high-quality and sustainable industrial development.[9]

3.4. Theoretical Value of Integrated Application of Blockchain + AI Evidence Storage Technology

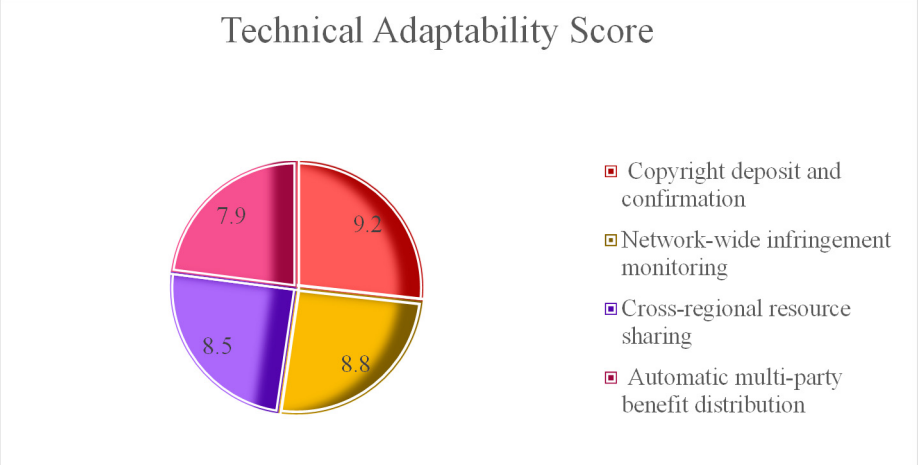


Figure 3. Application Adaptability Score of Blockchain + AI Evidence Storage Technology

The integrated application of blockchain + AI evidence storage technology in the field of marine education has achieved three major theoretical breakthroughs: first, **trust theory innovation**, building a decentralized technical trust system to replace traditional third-party intermediary trust, solving the lack of trust in digital resource management; second, **protection mode innovation**, realizing the transformation of copyright protection from passive rights protection to active prevention and control, building a whole-process protection system of prior right confirmation, in-process monitoring and post-traceability; third, **development mode innovation**, balancing the contradiction between resource sharing and copyright protection, realizing the collaborative development of efficient sharing, effective protection and fair distribution, and promoting the benign cycle of marine education resource construction.

4. Construction of Marine Education Resource Sharing and Copyright Protection Mechanism Based on Blockchain + AI Evidence Storage

Based on the actual development needs of marine education resources and relying on the integrated advantages of blockchain + AI evidence storage technology, build an innovative mechanism of **five core mechanisms + full-process closed-loop operation** for sharing and copyright protection of high-quality marine education curriculum resources, realizing intelligent, standardized and efficient operation of the whole process of right confirmation, evidence storage, sharing, monitoring, rights protection and distribution.[10]

4.1. Automatic Right Confirmation and Evidence Storage Mechanism for Resource Creation

Build a marine education curriculum resource right confirmation and evidence storage system based on consortium blockchain. Connect education competent departments, copyright administration authorities, universities, scientific research institutions, resource developers, platform operators and judicial organs as consensus nodes on the chain, and formulate nationally unified standards and operational procedures for copyright confirmation and evidence storage. It realizes copyright confirmation upon creation, evidence storage upon uploading, and legal effect upon chaining.When original developers upload marine education curriculum resources to the consortium blockchain platform, the AI system automatically conducts full-dimensional content identification and originality verification, standardizes resource formats, extracts core feature data, and generates exclusive and unique digital content fingerprints. Meanwhile, encrypted processing is conducted on information including original author, creation time, revision records, content details, copyright statements and authorization scope. After verification through blockchain consensus mechanism, data are stored in distributed nodes on the chain synchronously, automatically generating non-tamperable evidence certificates with timestamps.The whole process of copyright confirmation and evidence storage is fully online and automatic without manual review or offline registration, enabling batch rapid copyright confirmation of massive resources. The on-chain data can be directly connected with copyright administrative departments and judicial authorities, possessing complete judicial legal effect. It fundamentally solves the difficulties of copyright confirmation, evidence storage and ambiguous ownership, providing authoritative basis for subsequent copyright protection.[11]

4.2. Cross-Domain Secure Sharing and Circulation Mechanism

Build a national integrated high-quality marine education curriculum resource sharing platform based on consortium blockchain, breaking geographical, departmental and subject restrictions to realize global resource integration, standardized management and secure sharing. The platform formulates unified standards for resource access, review, classification, release and retrieval, and standardizes on-chain uploaded resources of all entities, thoroughly solving problems of resource fragmentation and inconsistent standards.Adopt blockchain authority control and hierarchical sharing mode. According to attributes and audiences, marine education resources are divided into three categories: public welfare free resources, authorized resources and paid exclusive resources, with preset use authority, dissemination scope, service life and authorization conditions. When users submit resource application requests, the system automatically verifies user identity and qualification, and smart contracts automatically complete authorization review, permission granting and resource access in accordance with preset rules, realizing point-to-point secure, standardized and efficient resource circulation.At the same time, distributed storage technology is adopted to back up resource data in multiple on-chain nodes to ensure permanent resource security without loss. The whole sharing and circulation track is fully recorded and traceable, prohibiting unauthorized dissemination, over-range use and illegal diffusion. It safeguards the bottom line of copyright protection while realizing efficient resource sharing.

4.3. Full-Process Infringement Monitoring, Traceability and Rights Protection Mechanism

Construct a full-process closed-loop rights protection mechanism of **AI real-time monitoring + blockchain accurate traceability + electronic evidence fixation**, transforming copyright protection from passive remedy to active prevention.

Pre-prevention: The AI system conducts comprehensive originality verification on all platform-accessed resources, compares content fingerprints, intercepts pirated and infringing resources from online access, and builds the first line of copyright defense through on-chain copyright confirmation of all original resources.

In-process monitoring: The AI infringement monitoring system crawls data from all network channels all-weather and full-coverage, and conducts real-time rapid comparison with on-chain original resource fingerprints. Once identifying piracy, unauthorized reprinting, tampering and selling, illegal dissemination and other infringements, multi-channel early warnings are immediately sent to original authors and platform supervisors. Key electronic evidence such as infringing content, links, dissemination data and infringing subjects are automatically captured, encrypted and solidified, and uploaded to blockchain for evidence storage in real time

to ensure evidence non-tamperability.

Post-rights protection: Relying on the full traceability feature of blockchain, retrieve full-life-cycle on-chain records to completely restore the whole track of resource creation, dissemination and infringement, accurately trace infringement sources and define responsible subjects. The on-chain solidified electronic evidence chain has complete judicial effect, which can be directly used for complaint handling, judicial litigation and copyright dispute mediation. It simplifies rights protection procedures, reduces costs, shortens cycles and improves success rate, realizing early discovery, early warning, early evidence collection and early disposal of infringements.

4.4. Multi-Party Fair Benefit Distribution Mechanism

Relying on blockchain smart contract technology, build a transparent, automatic, traceable and fair benefit distribution mechanism to balance interests of resource developers, disseminators, platform operators and users, and stimulate enthusiasm for resource development and sharing.For public welfare marine education curriculum resources, diversify incentive methods including honor recognition, achievement assessment, policy support and financial subsidies. Incorporate resource sharing effects into scientific research assessment and institutional rating to improve motivation for public welfare resource development and sharing. For market-oriented paid resources, smart contracts preset benefit distribution ratio, rules, settlement cycle and payment standards, automatically calculate resource usage frequency, download volume and total income, and complete income settlement, transfer and distribution automatically in accordance with rules.

The whole process requires no third-party intermediaries. All distribution processes and data are publicly available and verifiable on the chain, prohibiting black-box operation, unfair distribution and embezzlement of original income. It effectively protects intellectual achievements and economic rights of original developers, achieves mutual benefit of all parties, and constructs a benign marine education resource development ecosystem.

4.5. Full-Life-Cycle Copyright Management Mechanism

Focusing on the full life cycle of marine education curriculum resources: **creation—upload—evidence storage—review—sharing—dissemination—removal—archiving**, construct an integrated full-process copyright management mechanism to realize omni-directional and dead-angle-free copyright management.

Establish a dynamic updating mechanism for copyright information. Resource revision, authorization, transfer and income information are updated on the chain in real time to ensure accurate and complete copyright data. Build online channels for copyright objection handling, dispute mediation and violation punishment, quickly verify and fairly handle on-chain copyright disputes, and clarify dispute settlement procedures and responsibility identification standards. Establish a dishonesty punishment mechanism for infringers, include serious infringement acts into the industry dishonesty list, and implement platform access restrictions and joint sanctions to strengthen copyright constraints.Meanwhile, set up standardized management mechanisms for resource archiving, removal and updating, standardizing disposal of expired, invalid and illegal resources, and timely updating high-quality original resources. It realizes refined full-life-cycle copyright management of marine education curriculum resources.

4.6. Overall Operation Process of the Mechanism

Supported by blockchain consortium chain at the bottom and implemented by AI evidence storage technology, the overall mechanism forms a complete closed-loop operation:Original developers upload resources → AI generates content fingerprints & originality verification → blockchain copyright confirmation & evidence storage → standardized access to sharing platform after resource review → users apply for use → smart contract automatic authorization → secure resource sharing → AI full-network infringement monitoring → infringement early warning & evidence fixation → blockchain traceability & rights protection → smart contract automatic benefit distribution → full-life-cycle copyright management.The whole process is intelligent, automatic and transparent without manual intervention, ensuring both efficient resource sharing and all-round copyright protection.

5. Safeguard Paths for the Implementation of Blockchain + AI Evidence Storage Mechanism

5.1. Improve Top-Level Policies and Systems to Consolidate Legal Safeguards

5.1.1. Strengthen Policy Overall Planning and Guidance

Jointly issue special policies by national and local departments of education, copyright, development and reform, and cyberspace affairs, incorporate the application of blockchain + AI evidence storage technology into key plans for marine education digital development and intellectual property protection, clarify supporting policies, development goals and implementation details, and increase financial and project support to provide policy support for mechanism implementation.[12]

5.1.2. Improve Industrial Standards and Norms

Formulate nationally unified development standards, copyright confirmation & evidence storage standards, sharing service standards, copyright protection standards and technology application standards for digital marine education curriculum resources, and improve supporting norms such as resource classification, data interface, quality evaluation and infringement identification to promote industrial standardized development and ensure mechanism operation follows rules.

5.1.3. Improve Legal Safeguard System

Refine laws and regulations on judicial recognition of blockchain evidence storage and AI electronic evidence, clarify judicial legal effect of on-chain copyright evidence and electronic evidence, and smooth judicial channels for copyright rights protection. Increase law enforcement and punishment for infringements, raise illegal costs, and form a trinity institutional system of **policy guidance, standard specification and legal guarantee**.

5.2. Build Professional Integrated Platforms to Optimize Application Carriers

5.2.1. Build National Exclusive Platforms

Integrate high-quality resources of government,

universities, enterprises and scientific research institutions, set up professional operation teams, and build a national exclusive marine education resource platform based on blockchain + AI evidence storage, integrating resource management, copyright confirmation & evidence storage, sharing & circulation, infringement monitoring, rights protection service, benefit distribution and data analysis. Break data barriers among departments and entities to realize one-stop management of global resources.

5.2.2. Optimize Platform Functional Modules

Improve functional modules including copyright confirmation & evidence storage, intelligent retrieval, hierarchical sharing, real-time monitoring, evidence fixation, online rights protection, income settlement and credit management. Enhance system compatibility, stability, security and usability, simplify user operation procedures, lower thresholds for resource uploading and application, and balance professionalism and inclusiveness.[13]

5.2.3. Realize Multi-Party Data Docking

Realize data docking between the platform and education competent departments, copyright registration authorities, judicial organs and financial institutions, realizing full-online processing of qualification verification, copyright registration, judicial rights protection and income settlement to improve platform service capacity and operation efficiency.

5.3. Strengthen Technological R&D and Innovation to Enhance Technical Support

5.3.1. Accelerate Core Technology R&D

Support universities, scientific research institutions and technological enterprises to carry out special R&D on blockchain + AI evidence storage technology, optimize smart contract algorithms, content recognition algorithms, distributed storage and data encryption technologies. Improve technology accuracy, monitoring efficiency and security protection capabilities to adapt to diverse resource types and massive data processing needs of marine education.

5.3.2. Improve Security Protection System

Strengthen R&D on platform data security, privacy protection and network attack and defense technologies, build an all-round security protection mechanism to prevent data leakage, hacker attacks and system failures. Eliminate participation concerns and ensure security of user privacy, copyright information and resource data.

5.3.3. Promote Technological Iteration and Upgrading

Keep up with the development trend of digital technology, continuously promote technological iteration and function optimization, adapt to new needs of marine education resource development and new scenarios of copyright protection, and enhance mechanism adaptability and long-term effectiveness.

5.4. Cultivate Interdisciplinary Talents to Consolidate Talent Foundation

5.4.1. Build Collaborative Education System

Promote universities to set up interdisciplinary courses related to marine education, intellectual property, blockchain and artificial intelligence, improve curriculum systems, and cultivate high-end compound talents with marine education professional knowledge, copyright management capabilities and digital technology application capabilities to reserve talents for industrial development.

5.4.2. Carry Out Special Skill Training

Conduct special training on copyright protection, technical operation, platform operation and dispute handling for marine education workers, resource developers, platform operators and regulatory law enforcement personnel, improve professional literacy and practical capabilities of practitioners, and ensure efficient mechanism operation.

5.4.3. Introduce High-End Professional Talents

Introduce blockchain & AI technical experts, intellectual property legal experts and marine education management experts to provide professional guidance for mechanism design, platform construction, operation management and industrial standard formulation, and improve industrial professional development level.

5.5. Promote Multi-Party Collaborative Linkage to Gather Industrial Synergy

5.5.1. Establish Collaborative Supervision Mechanism

Clarify supervision responsibilities of education, copyright, cyberspace affairs, public security and judicial departments, establish cross-departmental collaborative supervision, joint law enforcement and information sharing mechanism to form supervision synergy, severely crack down on various infringements, and standardize industrial order.

5.5.2. Strengthen Participation of All Entities

Guide active participation of governments, universities, scientific research institutions, enterprises, popular science institutions and platform operators, clarify rights and obligations of all parties, and build an industrial development pattern of **co-construction, sharing, co-governance and win-win** to promote resource co-construction and rights co-protection.[14]

5.5.3. Strengthen Industrial Self-Discipline Guidance

Establish industrial associations for marine education resource construction and copyright protection, formulate industrial self-discipline norms, carry out industrial credit evaluation, guide market entities to operate standardizedly, respect originality and protect copyright, and improve industrial self-discipline level.

5.6. Carry Out Pilot Demonstration and Promotion to Implement Steadily

5.6.1. Hierarchical and Classified Pilot Application

Select coastal areas, key marine education universities, popular science institutions and digital education pilot areas for mechanism pilot application, accumulate experience through trial implementation, and optimize adjustments timely aiming at problems in pilot processes.

5.6.2. Summarize and Promote Mature Experience

Timely summarize pilot successful experience, operation modes and optimization plans, compile pilot guidelines and operational norms, and promote nationwide in stages and regions to avoid blind promotion and reduce operational risks.

5.6.3. Establish Long-Term Evaluation Mechanism

Build a mechanism operation effect evaluation system, regularly evaluate resource sharing efficiency, copyright protection effect, benefit distribution fairness and user satisfaction, and continuously optimize mechanism design and operation modes to ensure long-term effective operation of the mechanism.

5.7. Strengthen Publicity and Guidance to Create a Sound Atmosphere

Strengthen publicity on marine education copyright protection and digital technology application through media publicity, popular science activities and special training. Enhance social awareness of copyright protection and marine education, guide the public to use and disseminate resources legally, and resist infringements. Publicize advantages and values of blockchain + AI evidence storage mechanism, improve industry awareness and participation enthusiasm, and create a social atmosphere of respecting originality, protecting copyright and sharing high-quality resources.

6. Conclusion and Prospect

6.1. Research Conclusion

Against the background of in-depth maritime power strategy and comprehensive digital education transformation, aiming at core pain points of marine education high-quality curriculum resources including resource fragmentation, high sharing barriers, difficult copyright confirmation, frequent infringements, difficult rights protection and interest imbalance, this paper systematically analyzes core characteristics, application advantages and integrated adaptability of blockchain and AI evidence storage technology. An innovative mechanism integrating automatic copyright confirmation, cross-domain secure sharing, full-process infringement traceability, multi-party fair benefit distribution and full-life-cycle copyright management is constructed. Systematic and implementable implementation paths are proposed from six dimensions: policy system, platform construction, technological R&D, talent cultivation, multi-party collaboration and pilot promotion. The research verifies that the deep integration of blockchain + AI evidence storage technology fully adapts to sharing and copyright protection needs of marine education curriculum resources, fundamentally solving industrial development dilemmas. Non-tamperable evidence storage and rapid copyright confirmation solve difficulties of ambiguous ownership; decentralized sharing breaks resource barriers to realize efficient circulation; real-time monitoring and accurate traceability improve copyright protection efficiency and reduce rights protection costs; smart contract benefit distribution balances multi-party interests and stimulates industrial vitality. The constructed innovative mechanism realizes two-way balance between efficient resource sharing and all-round copyright protection, taking into account both public welfare attributes of marine education and intellectual rights of original creators, which is scientifically theoretical and practically feasible, conforming to digital, standardized and sustainable development needs of marine education.[15]

6.2. Research Limitations

There are still certain limitations in this research: first, in-depth research on technical details and algorithm optimization of blockchain + AI evidence storage mechanism is insufficient; second, differentiated mechanism design aiming at more segmented scenarios is lacking; third, cost accounting, profit model and long-term operation benefit analysis of mechanism implementation need further refinement. Follow-up research will be carried out aiming at the above deficiencies to further optimize mechanism design.

6.3. Research Prospect

In the future, with continuous digital technology iteration, continuous improvement of policy systems and gradual maturity of multi-party collaborative mechanisms, blockchain + AI evidence storage technology will achieve wider and deeper application in marine education, comprehensively innovating construction, management and protection modes of marine education resources. Follow-up research can further explore deep integration of blockchain + AI with metaverse, big data and 5G technologies, expanding new modes of immersive sharing, intelligent management and full-scenario protection of marine education resources. Continuously optimize mechanism design and platform functions to realize global inclusive sharing of marine education resources, improve copyright protection ecosystem, stimulate original innovation vitality, boost high-quality development of marine education, and provide stronger support for building maritime power, promoting digital education transformation and improving national marine literacy.

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