An Analysis of AR Applications in Children's Popular Science Book Publishing in the Age of Artificial Intelligence: A Case Study of the "Ocean Awareness Education" Series AR Products (Postprint)

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Abstract

Augmented Reality (AR) technology has been widely disseminated throughout digital and book publishing. AR superimposes virtual information onto the physical world, primarily aiming to sensorially integrate the real and virtual realms. The technical attributes of AR can introduce greater possibilities to children's science popularization book publishing, transforming print books into comprehensive all-media formats, substantially expanding book content, and considerably enhancing both interest and interactivity. This article employs the "Ocean Awareness Education" series of AR products as a case study to examine AR's application in children's science popularization book publishing within the artificial intelligence era, and to investigate novel models for the convergent development of AR and children's science popularization book publishing.

Full Text

Preamble

Title: Exploring the Application of AR in Children's Science Book Publishing in the Age of Artificial Intelligence: A Case Study of the "Ocean Awareness Education" AR Product Series
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Abstract: Augmented Reality (AR) technology has become widely adopted in digital and book publishing. AR overlays virtual information onto the real world, primarily aiming to merge the physical and virtual worlds at the sensory level. The technical characteristics of AR can bring greater possibilities to children's science book publishing, extending print books into full-media formats and

dramatically expanding book content while significantly enhancing interest and interactivity. This paper examines the application of AR in children' s science book publishing in the age of artificial intelligence, using the "Ocean Awareness Education" AR product series as a case study to explore new models for the integrated development of AR and children' s science book publishing.

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With the maturation of digital technology, the proliferation of the internet, and the continuous improvement of computing power, the age of artificial intelligence has begun. Big data, intelligent computing, AR, and VR have all endowed the publishing industry with new vitality. To pursue high-quality development in children' s digital publishing, we must not only adhere to content as king but also leverage advanced technologies as our vanguard [1]. Among these, the integration of AR technology with publishing represents an active exploration of innovation and transformation in China' s publishing field, particularly in the domain of children' s science books. AR publishing products superimpose the real world with the virtual world created by book content, extending children' s sensory experiences in science books through edutainment and satisfying young readers' desire for participatory reading. Consequently, AR technology holds great promise in the field of children' s science book publishing.

1. The Publishing Process of the "Ocean Awareness Education" AR Product Series

The "Ocean Awareness Education" project, initiated by China Publishing Group Corporation from 2015 onward, encompasses a series of AR products including the "Ocean Awareness" textbook series, *China Children' s Ocean Encyclopedia (First Series)*, *Illustrated Dream of a Maritime Power (Chinese Edition)*, *Illustrated Dream of a Maritime Power (English Edition)*, *Wonderful Ocean Classes*, multimedia courseware, audio-video materials, and an online education platform for primary and secondary school students. Its primary content combines mobile AR educational technology with books to achieve 3D content display and interaction, authentically recreating various scenarios to make ocean knowledge learning more visualized, three-dimensional, and dynamic.

1.1 Background of AR Product Development

The 21st century is the century of the ocean. With the rising strategic importance of maritime affairs, it has become increasingly vital to cultivate ocean awareness among primary and secondary school students. The root cause of weak national ocean awareness lies in the lack of ocean knowledge education

during the primary and secondary school stages. Therefore, the richly contented and engaging "Ocean Awareness Education" series of AR products greatly benefits the popularization of ocean knowledge, helping primary and secondary school students enhance their ocean awareness and thereby improving the entire nation's maritime consciousness. Based on this understanding, the publishing house innovatively explored this "Ocean Awareness Education" AR product series, which offers multiple benefits for the nation, its people, and society, while also delivering significant social benefits. The development of the "Ocean Awareness Education" book series and supporting digital construction project was thus launched. The construction of this AR product series complements the development and promotion of "Ocean Awareness Education," enabling online mobile reading of content through new technological means and filling the gap in "Ocean Awareness Education" within the context of mobile internet development.

1.2 Key Development Components

1.2.1 Creating Interactive Books Using AR technology, interactive books such as *Wonderful Ocean Classes*, *China Children's Ocean Encyclopedia*, and *Illustrated Dream of a Maritime Power* were created. QR codes inserted into the print science books allow users to scan and access multimedia content such as videos, creating virtual learning scenarios and narratives that deliver strong visual impact and multidimensional learning experiences, thereby achieving a combination of learning and play.

1.2.2 Mobile App Platform Development Beyond combining print books with QR codes, developing a mobile digital content platform for the entire "Ocean Awareness Education" AR product series constituted another crucial aspect of product development. Through the App platform, ocean knowledge could be better extended while simultaneously obtaining interactive data such as feedback, likes, and comments on related books.

1.2.3 AR Technology Development AR technology serves as the powerful backbone of the "Ocean Awareness Education" AR product series. Through AR technology, mobile data capture is implemented and combined with books to achieve three-dimensional digital content display and interaction, rather than remaining at simple interactive levels.

1.2.4 Constructing Digital Knowledge Points The "Ocean Awareness Education" AR product series encompasses 22 volumes of "Ocean Awareness" textbooks, 8 volumes of *Wonderful Ocean Classes*, 4 volumes of *China Children's Ocean Encyclopedia*, and 2 volumes of *Illustrated Dream of a Maritime Power*, meticulously introducing thousands of ocean-related knowledge points. Based on this, a system of digital knowledge points was established, enabling better presentation to readers through AR technology and making scattered ocean knowledge points more systematic and orderly, thus facilitating easier learning and absorption for children.

1.3 Supporting Factors for Success

1.3.1 Strong Expert Team The "Ocean Awareness Education" AR product series is backed by a powerful expert team, including over 30 advisors such as Academicians Ding Dewen and Jin Xianglong from the Chinese Academy of Engineering, Fang Nianqiao (former dean of the School of Ocean Sciences at China University of Geosciences, Beijing), Lu Rude (professor at Dalian Naval Academy), and Shen Wenzhou (researcher at the Institute of Marine Development Strategy of the State Oceanic Administration), along with dozens of research institutions jointly participating in production and compilation. Through their strong sense of social responsibility and rigorous scientific spirit, they provide scientifically professional text introductions, a large number of exquisite images, and content in audio, video, animation, and multimedia courseware formats, systematically and comprehensively introducing ocean knowledge from political, economic, cultural, and scientific perspectives to help young readers understand and recognize the ocean, thereby enhancing their awareness of blue territory, maritime economy, and marine environmental protection.

1.3.2 Alignment with National Strategy The "Ocean Awareness Education" AR product series project relies on innovative textbooks that adhere to the national maritime strategy—a key national strategy—during planning and publishing. This aligns highly with the "Belt and Road" development strategy. Market research revealed enormous market demand for children' s ocean knowledge books, and the planning and publication of "Ocean Awareness Education" fills this market gap, representing a dual-benefit product with both significant market potential and social benefits.

1.3.3 Excellent Educational System Resources The publishing house maintains strong cooperative relationships with provincial and municipal education departments and bureaus, ensuring publication quality when publishing children' s science books. It is also an important member of the National Children' s Ocean Education Promotion Association, maintaining close cooperation with several hundred primary and secondary schools affiliated with the association that serve as practice bases for ocean books and online courses. These excellent educational system resources are crucial guarantees for refining and deepening the "Ocean Awareness Education" AR product series.

2. Disintegration and Reconstruction: How "AR + Publishing" Transforms Children' s Science Book Publishing

As the age of artificial intelligence arrives, traditional books face increasing impact from digital media, and the publishing industry must innovate to survive by actively seeking change. Applying AR technology to book publishing can combine technological advantages with content strengths, leading the publishing industry toward a new path of development.

2.1 Technology Serving Content: Compensating for Text and Image Limitations

The application of AR technology in children' s books has become an advantageous means to deepen children' s understanding of book content. Many books have truly achieved technology serving content, compensating for the shortcomings of text and illustrations alone, which can be obscure, less engaging, and weakly interactive. The "Ocean Awareness Education" series, including *Wonderful Ocean Classes*, *China Children' s Ocean Encyclopedia*, and *Illustrated Dream of a Maritime Power*, are natural science books that demand high levels of logical reasoning, spatial imagination, and hands-on ability from readers. Young readers may only achieve partial understanding without careful reading. However, adding multimedia, three-dimensional, and visual AR presentations to the original science content increases reader interest, often leading them to scan and watch repeatedly. According to relevant research, on average, readers with AR interactive functions will repeatedly view the content and frequently demonstrate it to friends or family, enhancing the sense of realism during reading and thereby helping readers understand the content.

2.2 Reshaping Profit and Business Models: Reducing AR Publication Costs

AR technology was first applied in the military industry. Through technological development, it has gradually integrated with the book publishing industry, improving resource matching, reducing R&D costs, and minimizing resource waste, thereby reshaping the profit models and business models of the publishing industry and driving transformation in book publishing. Particularly in the application of AR in children' s science books, it has gradually become an essential element. As high-performance modeling technologies such as AR achieve breakthrough progress, the cost of AR publications will be greatly reduced, output display terminals and equipment will become more user-friendly, and publishing houses are sparing no effort to build AR technology support platforms and develop open-source, convenient engines to accelerate AR technology application, laying a foundation for subsequent AR book development such as multi-directional value-added print books, online revenue, and revitalizing existing digital resources [2].

In traditional publishing models, publishers and readers have an unequal relationship, with publishers as knowledge providers and readers passively receiving information. New-generation AR technology can greatly enhance reader interactivity and participation, allowing readers to actively experience rather than passively observe. AR technology provides a brand-new narrative method and perspective for reading. When children learn abstract knowledge, they need concrete interpretation. Pure language, text, and illustrations struggle to meet the understanding levels and cognitive needs of children across different age groups, especially since the "Ocean Awareness Education" series encompasses rich ocean knowledge that is somewhat distant from children' s real lives. Us-

ing AR technology to create rich three-dimensional resources enables children to obtain vivid and intuitive images of marine life, developing abstract thinking. Each knowledge point is carefully matched with corresponding videos to construct a vivid ocean picture for children.

2.3 Improving Work in Children' s Science Publishing

In traditional publishing and distribution activities, publishing institutions struggle to grasp user information and preferences, and comments on e-commerce pages may not contain meaningful information. AR books can change this situation to some extent by enabling direct big data monitoring of users, including browsing tendencies, click counts, and browsing trajectories—all of which can be tracked as monitoring data by the platform. Particularly in the field of children' s science book publishing, AR technology support has positive effects on promoting children' s social development and enhancing their interest in learning ocean knowledge. By using big data to record children' s learning growth curves, we can analyze learning characteristics in a targeted manner and effectively improve work in early childhood education publishing. Additionally, AR-enabled books play a crucial role in anti-piracy efforts. AR books can implement a "one book, one code" function through cloud platforms, enabling user big data acquisition, protecting copyright revenue, and ensuring content security.

3. Challenges and Responses: Difficulties and Keys to AR Integration with Children' s Science Book Publishing

The application of AR technology in children' s science book publishing must grasp publishing principles, avoid rigid adherence to old ways or reckless advancement, and require a clear understanding of the publishing landscape to overcome constraints and dilemmas. As technological conditions gradually mature, how the publishing industry should respond to trends and act accordingly has become an urgent question for the publishing sector.

3.1 Difficulties in AR and Children' s Science Book Publishing Integration

3.1.1 Technical Difficulties First, developing high-quality AR book products requires demanding network environments and software/hardware technology, especially since children' s science books need concrete content, resulting in high development costs. Establishing AR models involves producing text, images, audio-video, interactive interfaces, and special effects, and AR models and content require continuous updates, necessitating ongoing maintenance and support from professional content and technical teams.

Second, AR effects are often suboptimal with low content comfort. Currently, AR book products mainly achieve interaction through QR code or image scanning, which many audiences consider mere "window dressing" —essentially print

books in AR disguise. Meanwhile, mobile App development is also challenging, with low compatibility of book-supporting Apps frequently causing formatting errors, poor interactivity, and difficulty for users to provide timely feedback.

3.1.2 AR Product Publishing Difficulties First, the issue of homogeneous topic selection. Searching major book sales websites such as JD.com and Dangdang reveals that AR children' s science publications have concentrated themes, with "dinosaur"-related topics accounting for about half of science books, indicating serious follow-the-trend duplication. This content clustering and imitation phenomenon hinders the development of competitive leading and core products, creates vicious competition causing resource waste, and may even reduce the core competitiveness of AR science books in the entire publishing industry. In response to this, during AR product development, extensive surveys revealed a significant market gap for ocean-themed books, and active investment in publishing has achieved positive responses.

Second, book sales issues. The market sales of AR publications on major book sales websites such as JD.com and Dangdang are not optimistic, with most publishers reporting that AR book products have not met expected sales volumes and have received mediocre market responses. High pricing and blocked communication channels are important factors hindering sales [3]. Due to high development costs, book pricing is relatively high, making price an important factor affecting sales. The complete 8-volume set of *Wonderful Ocean Classes* is priced at 224 yuan, slightly higher than other book types. AR books also face problems in promotion and display, such as poor AR effect demonstration in offline sales and promotional videos failing to attract users' attention.

3.1.3 User Usage Difficulties First, AR children' s science books target young children who need electronic mobile devices for reading, requiring a certain degree of parental participation to help younger children read. However, children should not be exposed to electronic products for too long, requiring parental guidance and monitoring.

Second, each AR children' s science book has its own unique App, causing parents to fall into a cycle of "downloading one App for each book purchased." Additionally, VR publication content has sharing barriers, making it difficult for users to disseminate and share on a larger scale.

3.2 Keys to Addressing Challenges

3.2.1 Policy Support as the Key to Sustainable Development As early as 2017, the State Council issued relevant policies to promote artificial intelligence development. The *New Generation Artificial Intelligence Development Plan* explicitly stipulates: "Vigorously develop emerging AI industries: virtual reality and augmented reality. Break through key technologies such as high-performance software modeling, content shooting and generation, augmented reality and human-computer interaction, and integrated environments and tools"

[4]. Additionally, AI-related legal and regulatory issues were mentioned in the June 2020 session of the Standing Committee of the National People' s Congress, emphasizing the need to strengthen legislative theoretical research and attach importance to legal issues related to new technologies and fields such as artificial intelligence. Policy support helps promote the innovation and application of AR technology in the publishing industry, especially in the field of children' s science book publishing.

3.2.2 Quality Content as the Key to Book Publishing Education is a conscience-driven undertaking, and children' s science book publishing also requires publishers to produce books with integrity, firmly grounded in high-quality publishing content resources. In this regard, when planning the "Ocean Awareness Education" AR product series, well-known domestic scholars and ocean domain experts were invited to serve as professional knowledge advisors, participating from the manuscript organization stage through distribution. Children' s science book publishing must adhere to a child-centered approach, grounded in children' s needs, with a deeper understanding of AR technology characteristics and the value of science content, insisting on deep integration between publishing products and AR technology advantages. AR technology should be used to showcase the characteristics of children' s science books and convey their educational and reading value.

3.3.3 Talent Cultivation as the Key to Addressing Challenges In the age of artificial intelligence, continuously improving publishing practitioners' ability to master and apply emerging technologies is essential. Publishing practitioners must deeply understand AR technology and become proficient in it to achieve value-added publishing products. Based on this, conducting vocational training and education is crucial. For children' s science book editors, it is necessary not only to understand child psychology and development patterns but also to have a deep understanding of publishing content resources and product thinking—considering how to integrate content with children' s surrounding environments, how to create greater engagement and interactivity, and thereby provide young readers with novel experiences and deeper immersion.

The development of artificial intelligence will profoundly affect the entire publishing process. The rise of new technologies such as AR presents new opportunities for the traditional publishing industry, and publishing practitioners should act accordingly. The development trend of book publishing, especially children's science book publishing, is increasingly digital, intelligent, and interactive. Publishing institutions with economic advantages can be the "first to try," seizing opportunities in the "AR + Publishing" domain.

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Note: Figure translations are in progress. See original paper for figures.