Theory and Practice of Science and Technology
2025, VOL. 6, NO. 9, 226-230
DOI: 10.47297/taposatWSP2633-456943.20250609

Research on the Path of Popular Science Research and Study of Zhanjiang Mangrove Based on UGIS Cooperation Leadership

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ABSTRACT
The mangrove ecosystem possesses significant ecological and scientific research value, serving as an excellent medium for environmental education and scientific practice. As the city with the largest distribution area of mangroves in China, Zhanjiang holds immense potential for popular science research and study activities. However, it currently faces challenges such as insufficient resource integration, a weak content system, fragmented research themes, and ambiguous evaluation methods. Based on collaborative governance theory and social network theory, this study constructs a four-in-one UGIS cooperation model involving universities, government, institutions, and schools. It conducts in-depth research on Zhanjiang's natural ecology, cultural history, and industries, systematically elaborates on the roles and resource advantages of the four entities in the UGIS model, and proposes a practical pathway of "objective co-creation, resource co-development, curriculum co-research, activity co-implementation, outcome sharing, and effect co-evaluation." This approach aims to develop mangrove popular science education courses with local characteristics, enhance public awareness and emotional attachment to mangrove conservation, and promote harmonious development between mangroves and humans.

KEYWORDS
UGIS; Zhanjiang; Mangrove; Science Popularization; Research Study

1 Introduction

With the issuance of the "Opinions on Promoting Research Travel for Primary and Secondary School Students" by the Ministry of Education (2016), the term "research travel" officially appeared in a Ministry of Education document for the first time. As the "Double Reduction" policy deepens and ecological civilization education advances comprehensively, science popularization research travel, serving as a critical bridge connecting classroom knowledge with the real world, has become a significant direction in the reform of primary and secondary education. Mangroves, as unique ecosystems in tropical and subtropical coastal zones, possess multiple functions such as ecological protection, biodiversity conservation, and climate regulation, making them a natural classroom for ecological civilization education. Zhanjiang, as one of the regions with the largest and most concentrated distribution of mangroves in China, is home to the country's first national-level mangrove nature reserve, highlighting its significant ecological and scientific research value.

However, current research travel activities face challenges such as insufficient resource integration, a weak content system (Hong Xia, 2024), fragmented research themes, and ambiguous evaluation methods (Mao Jinqi, 2024). Studying and designing effective pathways for science popularization research travel is of great significance for addressing these issues.

In light of this situation, leveraging the UGIS cooperation model to integrate the advantageous resources of multiple stakeholders and incorporate local characteristics such as natural ecology, cultural history, and industry can help construct a new paradigm for science popularization research travel focused on Zhanjiang's mangroves. This approach provides new ideas for overcoming the bottlenecks in the development of science popularization research travel. The implementation of this model will help participants gain an in-depth understanding of the local environment, fostering a sense of local identity and pro-environmental behavior. This, in turn, will lead to a long-term shift in perspectives, enhancing participants' emotional connection to the locality and motivating them to actively care for, respect, and protect the local environment. Such efforts are of profound significance for improving scientific literacy, advancing ecological civilization construction, and cultivating a sense of national pride and responsibility.

2 Literature review

2.1 UGIS collaborative model

Multiple studies highlight the necessity for collaboration among universities, government, primary/secondary schools, and professional institutions (e.g., libraries, museums, nature reserves). Although the specific term "UGIS" may not always be used, the underlying concept of such cooperation is widely recognized as crucial for addressing challenges related to resources, teaching capacity, and professional expertise (Hong Xia et al., 2024).

2.2 Educational perspective of research travel

Within the context of cultural and tourism integration, "research travel" has emerged as an optimal approach for achieving deep, culturally-rich tourism experiences. Ritchie (2003) defines research travel as travel activities where "learning" constitutes a primary component for the involved participants. These individuals engage in research travel primarily to acquire knowledge and practical education, while also seeking travel experiences (Zhou Ru, 1999). Research by Hong Xia (2024) indicates that research travel serves as an effective pathway for cultivating students' core competencies. Specifically regarding mangrove research travel, its value is particularly evident in enhancing ecological literacy, promoting interdisciplinary learning, and fostering the deep integration of ecological conservation and education.

Interpreting these viewpoints from an educational perspective, it is clear that research travel involves learning activities conducted by participants during their travels. Travel serves as the vehicle for learning, while research is the defining characteristic; thus, education is the fundamental attribute, and travel is the essential context. In designing research travel activities, emphasis should be placed on the deep integration of culture, travel, education, and practice.

2.3 Contributions of the four parties in the ugis to the practical research on zhanjiang mangroves

Through theoretical research and field investigations, it has been found that the Zhanjiang Mangrove Reserve Administration (2022) has strengthened publicity efforts. It has established external publicity platforms such as a mangrove education and publicity center, field education and publicity spots, websites, and official WeChat accounts. It has also formed a team to compile teaching materials and guide environmental education in schools. Every year, on World Wetlands Day, World Environment Day, World Biodiversity Day, and other occasions, it collaborates with relevant units to carry out themed activities. These activities provide the public with environmental education on mangroves, publicize the significance of protecting wetland biodiversity, and enhance the public's awareness of protection. Additionally, it organizes activities such as popular science entering campuses, nature education, and environmental education, and establishes pilot schools for mangrove environmental education and wetland experimental schools to boost teenagers' enthusiasm for mangrove protection. It also cooperates with universities and non-governmental organizations to conduct online and offline mangrove popular science activities, and issues initiatives to primary and secondary school students and the public across the city to protect mangroves. These efforts expand the social impact of environmental education and continuously raise the public's awareness of environmental protection.

Colleges and universities have established and developed "Mangrove Research Institutes", which are built into research institutions integrating scientific research, resource protection, and science popularization, aiming to become a highland for mangrove research in Guangdong Province. Currently, research teams are conducting in-depth studies on aspects such as endangered mangrove resources and ecological restoration, mangrove medicinal resources, mangrove ecological blue carbon, mangrove ecosystem monitoring, and mangrove culture and spirit. These studies provide theoretical support and scientific research guarantees for Zhanjiang to build a "Mangrove City". The research results are presented to the public in various forms of science popularization to enhance the public's in-depth understanding of mangroves.

Some social groups have also voluntarily organized Zhanjiang mangrove nature education volunteer teams. These teams train nature education instructors, organize bird-watching and bird-protection study tours, participate in mangrove patrols, and hold mangrove cultural and creative product design competitions. Their goal is to expand the team of Zhanjiang mangrove popular science education, promote the popularization of mangrove knowledge into government agencies, campuses, enterprises, rural areas, and communities, and improve the whole people's understanding of mangroves.

Hong Xia et al. (2024) found in their research that primary and secondary school teachers lack professional backgrounds in mangrove ecology and other related fields, which results in insufficient professional guidance during study tours. Therefore, primary and secondary schools often organize students to participate in mangrove study tours as organizational units. They take nature reserves, wetland parks, geological parks, and other places as bases, where students observe, measure, and conduct research on mangroves (Ren Tingting, 2022).

3 Research path for Zhanjiang mangrove science education based on UGIS

3.1 Construction of the UGIS cooperation model and role positioning of participating entities

The UGIS cooperation model features clearly defined roles and responsibilities for all participating entities. Their distinct positioning is crucial for driving industry advancement and ensuring project implementation.

Universities serve as the core of knowledge innovation and talent support. They act as theoretical guides, curriculum development hubs, and teacher trainers. Leveraging their resource advantages, they provide the latest mangrove

research findings, host expert think tanks in fields like ecology, environmental science, and education, and offer superior laboratory and herbarium facilities. Additionally, they provide a resource of highly educated and scientifically literate postgraduate and undergraduate student volunteers. Consequently, they play a significant role in project guidance and activity organization.

Government serves as the core of policy support and overall coordination. It acts as policy formulator, resource coordinator, and quality regulator. Due to its public service mandate and operational nature, it typically provides macro-level policy and financial support, such as dedicated research travel funds. It coordinates departments like the Nature Reserve Administration Bureau, Education Bureau, and Culture and Tourism Bureau, establishes safety management protocols and access standards, and provides direction and support for regional planning and development.

Institutions serve as the core of technology transfer and platform services. They act as practical platform providers, technical supporters, and publicity promoters. According to their institutional characteristics and societal roles, entities like mangrove nature reserves, museums, science and technology museums, and science education bases provide the public with professional venues, facilities, interpretation systems, and even support in activity planning and science education product development.

Primary and Secondary Schools serve as the core of educational demand and practical implementation. They act as demand proposers, curriculum implementation bodies, and feedback providers on effectiveness. Due to their large scale and numerous personnel, they provide clear requirements regarding student learning conditions and curriculum standards, organize student participation, provide feedback on teaching practice outcomes, and facilitate the integration of research travel achievements with school-based curricula.

3.2 Practical pathway for Zhanjiang mangrove science education research

Based on preliminary research and project implementation, this study proposes a UGIS "Six Co-" practical pathway to ensure the sustainability and effectiveness of the collaboration.

Co-creation of Objectives. Establish the "Zhanjiang Mangrove Science Education Research Alliance" and hold regular joint meetings. Based on national curriculum standards, core competency requirements, and the unique characteristics of Zhanjiang's mangroves, jointly define the overall objectives and specific competency indicators for research activities across different educational stages. This ensures the objectives are scientific, educational, and regionally distinctive.

Co-development of Resources. Construct a physical resource repository and collaboratively create a "Zhanjiang Mangrove Science Education Map," identifying observation points and experimental sites suitable for different inquiry themes. Concurrently, develop online resources by building a digital resource platform that integrates expert lecture videos, species databases, virtual simulation experiments, and research activity packages to enable resource sharing.

Co-research of Curriculum. Establish a "Curriculum Development Workshop" involving university teaching staff, subject education experts, key primary and secondary school teachers, and reserve engineers. Adopting a "Project-Based Learning" approach, design serialized and tiered curriculum modules tailored to the developmental characteristics of various age groups.

Co-implementation of Activities. Implement a "Dual-Teacher" or "Multi-Teacher" system. Primary and secondary school teachers are responsible for organization and management, university research teams act as "Science Mentors" guiding inquiry, and reserve engineers serve as "Practical Mentors" explaining field knowledge. Conduct joint training before activities to ensure clear division of labor and smooth transitions.

Co-sharing of Outcomes. Establish a diversified mechanism for outcome production and display. This includes student research reports, technological works, and nature notes; exemplary teaching cases developed by teachers; and annual research reports, popular science publications, and open classes jointly released by the alliance, thereby expanding social impact.

Co-evaluation of Effectiveness. Construct an evaluation system combining formative and summative assessments with multi-stakeholder participation. Utilize methods such as questionnaires, interviews, work analysis, and performance evaluations to conduct a comprehensive assessment across multiple dimensions, including student competency development, teacher professional growth, curriculum quality, and collaboration mechanism effectiveness. Feedback from the evaluation is then relayed back to the "Co-creation of Objectives" phase to optimize subsequent research activities, forming a closed-loop management system for continuous improvement.

3.3 Design strategies for mangrove science education research

Outdoor environmental education can interconnect with numerous educational fields, making learning content more vivid and engaging. It may encompass environmental education, school camping, outdoor recreation, and more (Zeng Qiming et al., 2015). This highlights that the greatest feature of outdoor environmental education is its ability to link relevant educational themes within the environment, fostering integrated learning experiences for students (Liu Huairu,

2010). Many scholars today believe that the most crucial aspect of environmental education is the connection between humans and the natural environment. Research by Li Zhiyong et al. (2016) indicates that members of the public who have experienced the ecological beauty and wonders of mangroves are more willing to pay additional costs for their conservation. Furthermore, higher income and education levels correlate with stronger willingness to pay and higher payment values. Additional domestic and international research findings show that integrating local issues, cultural history, and natural landscapes into environmental education programs not only encourages learners to actively engage with and solve related problems but also positively influences the environmental attitudes and behaviors of local community residents. This can manifest as a willingness to maintain the surrounding environment of their community and respect local natural and cultural resources, thereby influencing learners' emotional connection and attitude towards the land (Cai Keguang, 2018). Thus, when humans and nature coexist harmoniously, it can effectively enhance visitors' awareness and protective attitudes towards mangroves, subsequently increasing the value of these resources and better promoting the harmonious development of mangroves and humans.

Therefore, when designing research activities, the spirit of action research can be incorporated. By leveraging the natural ecology and cultural industry resources near mangrove ecological reserves, a series of environmental education courses can be developed. These courses should integrate environmental issues, scientific advancements, and the international situation, fostering the concept of a global community with a shared future. It is hoped that through firsthand experiences visiting urban wetlands, the public will deepen their emotional connection to their homeland, thereby enhancing their sense of environmental responsibility and civic awareness, as well as their interest and motivation in learning about nature. This, in turn, may lead to proactive participation in environmental education-related courses and the cultivation of positive environmental behaviors in the future.

Regarding science education methods, the findings from Liu Huairu's (2010) research on ecological science education strategies for mangroves in Quanzhou Bay, conducted during 2007-2008, indicated that on-site interpretation and technology-based experiences were the most effective approaches, followed by distributing science pamphlets and playing educational videos. This demonstrates that close, sensory interaction with nature most effectively facilitates science-public engagement, thereby promoting high-quality development of science education.

Based on this, the present study forms a systematic framework for the design and implementation of mangrove science education research activities (as shown in Figure 1). This framework starts with "Determining Objectives and Creating Themes" and follows a multi-stage iterative process, emphasizing the specific roles and division of labor for teachers and students at each stage. Teachers are primarily responsible for standard design, context creation, knowledge support, and activity organization, while students deeply participate through self-directed learning, group collaboration, field investigation, and outcome presentation.

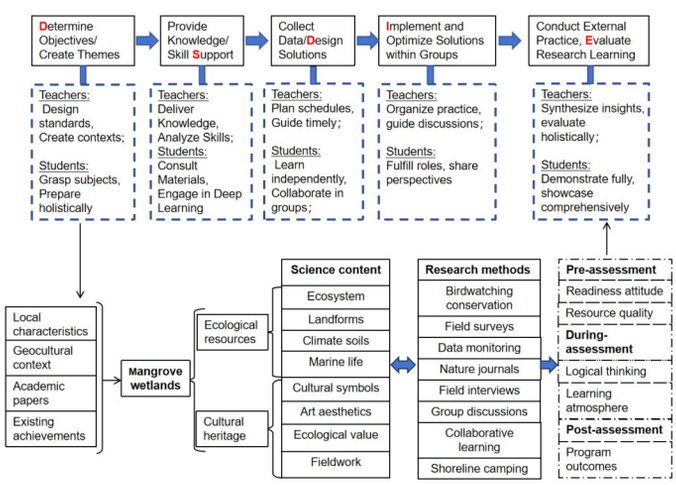

Figure 1 Framework for mangrove science program design and execution

The framework deeply integrates local characteristics and geo-cultural resources, focusing on mangrove wetlands. Starting from ecological and cultural resources, it designs multidimensional science content covering geology, marine life, aesthetic arts, and more. It also encompasses various research methods such as bird watching and protection, data monitoring, and nature journaling. The evaluation system runs through the entire process, covering pre-learning resource preparation, in-process performance, and post-learning outcome assessment, forming a closed-loop management mechanism. This reflects strong scientific rigor and practicality, providing a structurally complete and clearly layered practical pathway for mangrove science education research.

4 Conclusion

Zhanjiang boasts abundant mangrove ecosystem resources. Local governments and relevant institutions should focus on leveraging their leading role and, while properly managing the relationships between the mangrove ecosystem, local residents, research project development departments, researchers, and science education, proactively collaborate with primary/secondary schools and communities to organize diverse, knowledgeable, engaging, inspiring, and participatory mangrove ecological resource science education research activities. This will enhance public participation.

Universities should also actively fulfill their social responsibilities as research institutions. By aligning with annual science outreach events such as "Bird Loving Week," "National Science Popularization Day," and "World Earth Day," they should conduct diverse and effective publicity campaigns through online platforms, television, and social media. This will raise the profile of Zhanjiang's mangrove ecological research and, consequently, increase public awareness and protection of the mangrove ecosystem, ultimately forging Zhanjiang's golden name card as the "City of Mangroves."

Funding

This research was supported by the 2025 Zhanjiang Philosophy and Social Sciences Planning Project "Research on Zhanjiang Mangrove Science Education Pathways Based on UGIS Collaborative Leadership", the 2024 Peak Discipline Construction Special Project of Lingnan Normal University "Research and Practice on Digital Transformation Promoting the Development of U-G-I-S Integrated Teacher Education: Taking Primary School Science Large-Unit Teaching as an Example", and the 2022 Open Project Fund of Mangrove Research Institute of Lingnan Normal University (NO: PYXM17)

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