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Fostering Environmental Stewardship through Mangrove Ecotourism: A Study on Gili Sulat's Educational Impact

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Abstract

This study investigates the educational impact of mangrove ecotourism in Gili Sulat, Lombok, Indonesia, against the backdrop of increasing recognition of mangrove ecosystems for their ecological significance and the role of ecotourism in promoting environmental stewardship. Given the urgent need for conservation amidst threats from climate change and deforestation, this research aims to assess how mangrove ecotourism can enhance environmental awareness and education among students, and foster a deeper understanding of sustainable practices. Utilizing a qualitative approach, the study engaged 22 fifth-semester Biology Education students from Universitas Islam Negeri Mataram, who participated in educational practicums within the Gili Sulat mangrove ecosystems. Data were collected through structured questionnaires and interviews, focusing on the students' perceptions, experiences, and the educational value derived from their interactions with the mangrove environment. The findings underscore the immersive nature of ecotourism as a powerful educational tool, offering insights into the complexities of marine biodiversity, conservation efforts, and the critical role of mangroves in coastal protection and climate change mitigation. Conclusively, the study affirms the potential of mangrove ecotourism in Gili Sulat as an effective platform for fostering environmental stewardship, suggesting the need for enhanced educational programming, community involvement, and sustainable management practices to maximize its benefits.

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INTRODUCTION

The study of mangrove ecotourism as an educational and learning facility is crucial in the current context of environmental education and sustainable tourism. Mangroves are unique coastal ecosystems that provide critical habitats for diverse marine life and are often referred to as the "nurses of the sea" (Harto et al., 2021). The transformative potential of

mangrove ecotourism lies in its ability to showcase the natural beauty of these ecosystems and serve as a dynamic platform for environmental education and experiential learning. The conservation of carbon-rich mangroves has been identified as a high-priority component of strategies to mitigate climate change, with deforestation and conversion of mangroves contributing significantly to global emissions from tropical deforestation (Murdiyarso et al., 2015). Furthermore, the economic subsystem of mangrove ecotourism is composed of response variables such as ecotourism management income, community business income, and gross regional domestic product, highlighting the economic and ecological dimensions of this form of tourism (Utami et al., 2022).

Mangrove ecosystems are highly valued for their ecological benefits, serving as critical coastal habitats that contribute significantly to carbon sequestration, sea-level rise mitigation, and protection against storm surges. Bandh et al. (2023) have highlighted the essential role mangroves play in climate change mitigation and the urgent need for their conservation. The exploration of mangrove ecotourism is paramount as it offers a means for individuals to experience firsthand the ecosystem services mangroves provide, thereby deepening the public's comprehension of their vital role in addressing climate change.

Mangrove ecotourism, located at the nexus of recreation and education, presents an unparalleled opportunity to disseminate the importance of these ecosystems to a diverse audience. The engaging nature of ecotourism experiences, as detailed by Samal and Dash (2023), is capable of creating enduring impressions and knowledge. This research aims to investigate the function of mangrove ecotourism as an educational tool, enhancing societal awareness of the complex ecological dynamics within mangrove ecosystems and contributing to the cultivation of an environmentally knowledgeable populace.

The significance of community engagement and the harnessing of local knowledge in the development of mangrove ecotourism have been underscored by several researchers. The involvement and empowerment of local communities are deemed vital for the successful implementation of mangrove ecotourism projects, necessitating the creation of regulations and policies that reflect local wisdom to ensure mangrove preservation (Harto et al., 2021). Furthermore, the feasibility of mangrove areas for ecotourism has been evaluated, with findings supporting the viability of these regions for sustainable tourism development (Apdillah et al., 2023; Nelly et al., 2020; Riyadi et al., 2022). The importance of community roles within mangrove settings has also been demonstrated, with positive perceptions noted in specific villages, highlighting the significance of local backing and participation in mangrove ecotourism endeavors (Wopa et al., 2022).

Mangrove ecotourism extends beyond ecological advantages, presenting substantial socioeconomic impacts, particularly for communities located near these vital ecosystems. Through the provision of employment and the generation of income, mangrove ecotourism plays a role in poverty reduction and promotes sustainable development (Apdillah et al., 2023). The research conducted by Kunjuraman et al. (2022) underscores the criticality of community engagement in the planning and management of ecotourism projects. The cultural

heritage and traditional knowledge of coastal communities are often closely linked with mangroves, making the preservation of these cultural aspects fundamental to sustainable ecotourism practices. Donohoe (2011) investigates the synergy between cultural heritage and mangrove conservation, advocating for cultural sensitivity within ecotourism ventures.

Mangrove ecotourism also has the potential to act as a driving force for conservation and restoration initiatives. Visitors' interactions with mangrove ecosystems enable them to observe the effects of human activities and understand the necessity of conservation firsthand. Ecotourism's role in raising conservation awareness and supporting restoration projects is highlighted in the work of Kiper (2013).

The development of educational programs and the establishment of interpretation centers within mangrove reserves are crucial for leveraging the educational benefits of ecotourism. These initiatives provide a structured means for imparting scientific knowledge, conducting guided tours, and engaging visitors with interactive displays, thus catering to a wide range of audiences including students, tourists, and local communities. Such efforts enhance public knowledge and cultivate environmental stewardship. However, challenges such as overcrowding, habitat disturbance, and improper waste management pose risks to the sustainability of mangrove ecotourism. Research by Sam et al. (2023) emphasizes the necessity of implementing and enforcing sustainable practices to counteract these negative impacts.

Moreover, mangrove ecotourism offers opportunities for public involvement in citizen science projects, transforming visitors into active participants in scientific research and conservation activities. Nesha-Dushani et al. (2023) demonstrate how ecotourists can collect essential data on mangrove ecosystems, thereby enriching scientific knowledge and instilling a commitment to environmental protection. Effective mangrove ecotourism relies on comprehensive policy frameworks that reconcile conservation objectives with the socioeconomic goals of local communities.

A prime example of ecotourism serving educational purposes is observed in mangrove tourism on Gili Sulat, Lombok, Indonesia. Situated in the Lesser Sunda region, Gili Sulat is an unpopulated island designated as an Aquatic Tourism Park. It showcases a rich array of coastal ecosystems, including mangroves, seagrasses, and coral reefs, providing a distinctive educational environment for students (Hilyana et al., 2020). The island's strategic location and its relatively pristine marine environments offer an ideal setting for educational exploration into the complex interdependencies within coastal ecosystems. Gili Sulat embodies an educational platform that encourages a deep appreciation for the dynamic relationships underpinning global biodiversity.

This introduction sets the stage for a detailed exploration of mangrove ecotourism as an educational and learning resource. The forthcoming sections will delve into various dimensions of this topic, utilizing current research and insights to furnish a thorough understanding of the contribution of mangrove ecotourism in Gili Sulat to education and learning. The primary objective of this study is to investigate the impact of mangrove

ecotourism in Gili Sulat on enhancing environmental stewardship and education among students, while examining the role of student involvement in the sustainable development of ecotourism. The formulation of the research problem is as follows.

- How does mangrove ecotourism in Gili Sulat influence students' environmental awareness and behaviors, and what is the extent of student participation in promoting sustainable ecotourism practices?

METHODS

Study Area and Participants

This research employs an exploratory methodology with a qualitative framework, aiming to investigate the impact of mangrove ecotourism in Gili Sulat, Lombok - Indonesia on enhancing environmental stewardship and education among students. Gili Sulat, characterized by its rich biodiversity and distinctive mangrove ecosystems, provided a fitting setting for the study of the educational impacts of mangrove ecotourism.

The study's participants comprised 22 fifth-semester students enrolled in a Biology Education program, who participated in practical educational activities on Gili Sulat. The participant demographic was characterized by an age range of 19 to 20 years, with an equal distribution across genders. The choice of Biology Education students as participants was strategic, ensuring that the respondents had a basic understanding of ecological concepts. This prerequisite knowledge was anticipated to enrich their perceptions and contributions to the study, offering deeper insights into the educational advantages offered by engagement with mangrove ecotourism..

Data Collection Instrument

This study utilized a structured questionnaire to collect data on the educational and learning benefits derived from mangrove ecotourism in Gili Sulat. The questionnaire was meticulously designed to probe participants' experiences, perceptions, and the knowledge they acquired during their practicums. It aimed to assess various aspects of mangrove ecotourism, such as its educational impact, its role in enhancing environmental consciousness, and its contributions toward fostering community involvement. Additionally, the instrument included open-ended questions, providing participants the opportunity to share qualitative insights into their personal experiences. To ascertain the validity and reliability of the questionnaire, it was subjected to a thorough review process by experts in ecology and education. This validation process was essential to confirm the instrument's relevance, clarity, and efficacy in capturing the intended data.

Sampling and Data Collection

The research utilized a purposeful sampling technique to select fifth-semester Biology Education students from Universitas Islam Negeri Mataram who were actively engaged in practicums on Gili Sulat. This targeted selection was based on the study's emphasis on exploring the educational benefits of mangrove ecotourism, making these students a

particularly relevant and informed cohort for the investigation. The process of data collection was conducted both during and subsequent to the practicum activities. Participants received a detailed briefing about the objectives and procedures of the study, ensuring their informed consent prior to participating. The administration of the questionnaires was executed in a systematic manner, affording participants ample time to introspectively consider their practicum experiences and articulate their insights. This phase of data collection was designed to thoroughly ascertain the educational and learning advantages offered by mangrove ecotourism.

Data Analysis

The collected data, derived from structured questionnaires and interviews, underwent qualitative analysis to distill valuable insights regarding the educational benefits of mangrove ecotourism in Gili Sulat. Employing qualitative analysis techniques as outlined by Creswell & Creswell (2018), such as thematic coding and content analysis, the research categorized and interpreted participant responses. This process facilitated the emergence of themes pertinent to educational outcomes, environmental consciousness, community involvement, and other significant factors. The qualitative methodology enabled an in-depth examination of participant perspectives and experiences, yielding a comprehensive understanding of the impact of mangrove ecotourism on education. The results were articulated in a narrative format, integrating direct quotations and illustrative examples to lend authenticity and depth to the presentation of the qualitative findings.

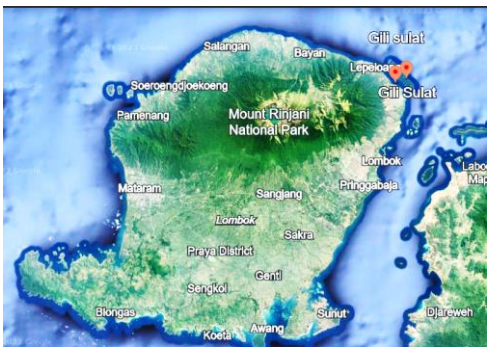
Ethical Considerations

Ethical considerations were meticulously observed throughout the research process, as emphasized by Yip et al. (2016). Prior to participation, informed consent was secured from all individuals involved, with explicit assurances regarding the confidentiality and anonymity of their contributions. The research was conducted in strict adherence to established ethical guidelines, prioritizing the respect and dignity of participants. Efforts were made to minimize any potential discomfort or harm to those involved. The questionnaire's validation process included an ethical review, ensuring the instrument's clarity, non-invasiveness, and alignment with the overarching goals of the study. Furthermore, the research team upheld a commitment to transparency, clearly communicating the study's purpose and objectives to all participants, thereby promoting a respectful, collaborative, and ethically sound research milieu, in line with the principles outlined by Felzmann (2009).

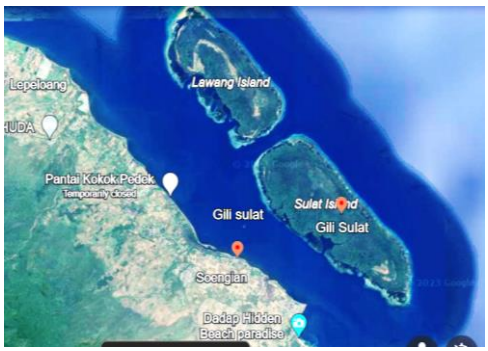
RESULTS AND DISCUSSION

Gili Sulat, located in the Lesser Sunda region, emerges as a notable site for educational exploration, especially for students interested in marine ecology. This uninhabited island, recognized as an Aquatic Tourism Park, presents a unique combination of coastal ecosystems, including mangroves, seagrasses, and coral reefs. The island's extensive mangrove ecosystem occupies 641,630 hectares, alongside 178,688 hectares of coral reefs and 47,599 hectares

dedicated to seagrass areas. This diverse and interconnected ecological array provides a comprehensive learning environment for students, as detailed by Hilyana et al. (2020).



(a) Lombok Island



(a) Location of Gili Sulat

(c) Gili Sulat Mangrove Forest

(d) Edge of Gili Sulat

Figure 1. Gili Sulat ecotourism area, Lombok – Indonesia

Gili Sulat's mangrove ecosystem plays a crucial role in its coastal landscape, offering students a dynamic environment for investigating the complex ecology of these distinctive areas. Adapted to saline conditions, the mangroves' intricate root systems act as breeding grounds for diverse marine species, providing students with a direct view into the symbiotic relationships within coastal ecosystems. The extensive seagrass beds underscore the importance of these habitats in sustaining marine biodiversity. Meanwhile, the island's coral reefs, teeming with life and color, exemplify the critical need for conservation efforts to preserve these fragile ecosystems. Gili Sulat, with its strategic location and relatively untouched marine environments, offers an exemplary setting for educational exploration, emphasizing the necessity of balance for sustainable living.

In addition to its ecological value, Gili Sulat serves as a comprehensive educational platform, encompassing cultural and socioeconomic elements. As an Aquatic Tourism Park, it highlights the importance of sustainable tourism and local community livelihoods. This multifaceted approach allows students to gain insights into marine ecosystems as well as the complex interplay between environmental conservation and community economic health. The island's initiatives in fisheries and ecotourism development present a practical example of sustainable practices, providing students with a real-world perspective on the integration of ecological, economic, and cultural aspects.

The feedback collected from fifth-semester Biology Education students through questionnaires and interviews sheds light on the educational impacts of their visits to Gili Sulat's mangrove tourism sites. This analysis will cover a range of topics, including the primary objectives of their visit, perceptions of the educational content, comprehension of the mangrove ecosystem's function, effects on academic competencies, interactions with local flora and fauna, motivations for environmental conservation, suggestions for enhancing educational resources, intentions for future visits, recommendations for others, experiences at other mangrove tourism sites, evaluations of educational outcomes elsewhere, commitments to environmental conservation, and proposals for augmenting the educational value of mangrove tourism in Gili Sulat.

- ***Main purpose of the visit***

Student A (S-A)'s response regarding the main purpose of their visit to Gili Sulat is as follows.

> *"The primary purpose of our visit was educational, aimed at learning about the unique ecosystem of Gili Sulat. This trip was an integral part of our Biology Education curriculum, focusing on the practical application of theoretical knowledge regarding coastal ecosystems."*

The overwhelming response indicated that the main purpose of the students' visit to mangrove tourism on Gili Sulat was education and learning aligns with the fundamental goal of ecotourism. As noted by Arrobas et al. (2020), education is a central component of sustainable tourism, contributing to increased environmental awareness and fostering a sense of responsibility among visitors. Gili Sulat's unique ecosystem, consisting of mangroves, seagrasses, and coral reefs, positions it as an ideal setting for educational exploration, attracting students eager to deepen their understanding of coastal ecosystems (Pechinkina et al., 2019).

Furthermore, the study by Pechinkina et al. (2019) emphasizes the role of education in enhancing ecotourism, particularly for local communities. This aligns with the educational aspect of mangrove tourism, as effective communication with tourists is essential for providing educational experiences and fostering environmental awareness (Weaver & Lawton, 2007). This aligns with the emphasis on education and learning as the main purpose of students' visits to mangrove tourism on Gili Sulat, as it underscores the significance of integrating environmental education into tourism studies. Moreover, the study by Baum et al. (2016) stresses the importance of embedding sustainability concepts and practices in teaching and research in higher education, further supporting the educational and sustainability aspects of mangrove tourism.

- ***Most interesting aspect regarding education in mangrove ecotourism***

Student C (S-C)'s response regarding the most interesting aspect regarding education in mangrove ecotourism is as follows.

> *"For me, the most interesting aspect was experiencing the mangrove ecosystem firsthand. Observing the diverse species that thrive in this environment and understanding the ecological processes at play was incredibly fascinating. It provided a vivid context to the ecological concepts we've studied in class."*

The students' firsthand exposure to the unique mangrove ecosystem provided them with the opportunity to observe diverse species and understand the ecological processes at play, stimulating their curiosity and fostering a deeper appreciation for the interconnectedness of coastal ecosystems. This finding is consistent with Angela (2023), who emphasizes the educational value of unique and diverse environments in ecotourism, highlighting how such environments enhance the learning experience and foster a deeper understanding of ecological concepts. Additionally, the students' consensus on the significance of biodiversity and ecological complexity in educational experiences aligns with Gultom et al. (2021), who found that local communities are increasingly realizing the importance of mangroves for mitigating the impact of natural disasters, such as tsunamis, and are actively participating in mangrove planting and management. This underscores the educational and ecological significance of mangroves, as they serve as natural buffers against environmental hazards and provide valuable learning opportunities for students.

Furthermore, the students' first hand experience with the mangrove ecosystem aligns with Wu et al. (2023), who found that experiential learning-based field trips to natural reserves, such as mangroves, can significantly improve participants' mental models of the local ecosystem, meeting educational needs beyond mere entertainment. This supports the idea that direct exposure to unique environments, such as mangroves, can enhance students' understanding of ecological concepts and the value of biodiversity. Additionally, the significance of mangroves in educational settings is further supported by Tagulao et al. (2022), who reported consistently positive evaluations of the impact of environmental education programs, emphasizing the role of such programs in raising awareness and influencing positive attitudes towards the preservation and conservation of marine ecosystems, including mangroves. These findings collectively highlight the educational and ecological significance of firsthand experiences in unique ecosystems, such as mangroves, in fostering a deeper understanding of ecological concepts and biodiversity appreciation among students.

- ***Prior knowledge about ecotourism***

Student F (S-F)'s response regarding to the prior knowledge about ecotourism is as follows.

> *"Before visiting Gili Sulat, my understanding of ecotourism was relatively basic. Although I was aware of its importance in conservation and sustainable tourism, the trip significantly deepened my knowledge, especially regarding its role in educating the public and fostering environmental stewardship."*

The revelation that the students had not learned about ecotourism before their visit to Gili Sulat suggests that the educational benefits extend beyond conventional classroom

learning. Experiential learning in ecotourism settings can bridge gaps in formal education, providing practical insights that may be missed in traditional educational settings. Gili Sulat, by serving as a practical classroom, introduces students to the principles and practices of ecotourism organically. The concept of ecotourism has gained increasing attention due to its potential to contribute to conservation and sustainable tourism practices. The experiential learning aspect of ecotourism has been highlighted as a valuable tool for enhancing public understanding and fostering environmental stewardship. Lee and Jan (2018) provide a comprehensive framework for understanding the behavior of nature-based tourists in the context of ecotourism. Their study emphasizes the role of environmental attitudes, subjective norms, and perceived behavioral control in influencing ecotourism behavior among tourists (Lee & Jan, 2018). This framework aligns with the experiential learning aspect mentioned in the student's response, as it underscores the importance of understanding tourists' attitudes and intentions towards ecotourism.

Moreover, Yoon and Lee (2023) investigated the impact of ecotourism knowledge on residents' attitudes in a regional community, emphasizing the relevance and complexity of ecotourism knowledge in shaping positive attitudes towards tourism development (Yoon & Lee, 2023). This aligns with the student's observation that experiential learning in ecotourism settings can bridge gaps in formal education and influence attitudes towards ecotourism. Additionally, examines the role of ecotourism in conservation, drawing from numerous case studies to assess the ecological sustainability of ecotourism regimes (Krüger, 2005). This supports the student's insight that Gili Sulat serves as a practical classroom, introducing students to the principles and practices of ecotourism organically, thus contributing to the broader understanding of ecotourism's role in conservation and sustainability.

- ***Understanding of the mangrove ecosystem's role***

Student H (S-H)'s responses regarding understanding of the mangrove ecosystem role are as follows.

> *"The visit enhanced my understanding of the mangrove ecosystem's crucial role in protecting coastal areas, supporting marine biodiversity, and mitigating climate change impacts. It was enlightening to see how mangroves serve as a natural barrier against erosion and provide habitats for a variety of marine life."*

The affirmative response to understanding the role of the mangrove ecosystem in protecting the marine and coastal environment aligns with the ecological principles that underscore the significance of mangroves in coastal resilience. This understanding is critical for fostering environmental stewardship. Studies by De-Dominicis et al. (2023) emphasize the pivotal role of mangroves in protecting coastal areas, highlighting the importance of disseminating this knowledge through ecotourism experiences.

Mangroves act as a natural barrier against erosion and provide habitats for a variety of marine life. Studies by Giri et al. (2011) emphasize the pivotal role of mangroves in protecting coastal areas, highlighting the importance of disseminating this knowledge through

ecotourism experiences. Furthermore, previous research highlights mangroves as tropical ecosystems with extremely high carbon storage, emphasizing their significant role in mitigating climate change (Aye et al., 2022). Additionally, the study by Sinaga et al. (2023) provides valuable insights into the carbon stock assessment of mangrove vegetation, emphasizing the substantial biomass and carbon stock of mangrove ecosystems. These studies collectively support the understanding of the crucial role of mangroves in carbon sequestration, coastal protection, and biodiversity support, aligning with the ecological principles that underscore the significance of mangroves in environmental stewardship.

- ***Support for course competency***

Student J (S-J)'s response regarding course competency support after visiting Gili Sulat is as follows.

> *"The hands-on learning experience at Gili Sulat directly supported our course competencies by allowing us to apply classroom knowledge in a real-world setting. It was a perfect blend of theoretical learning and practical application, enhancing our skills and understanding of marine ecosystems."*

The perception that the practical activity on Gili Sulat strongly supports the final competency of the course aligns with the transformative potential of practical experiences in education. As discussed by Satrya et al. (2019), hands-on experiences in ecotourism settings can enhance students' understanding of theoretical concepts and contribute to the development of practical skills. The integration of experiential learning in the mangrove tourism context ensures a holistic approach to achieving course competencies. The integration of experiential learning in the context of mangrove tourism ensures a comprehensive approach to achieving course competencies, as it allows students to gain practical insights into marine ecosystems and apply their knowledge in a real-world context (Jin et al., 2015). Furthermore, the study by Wu et al. (2018) on experiential quality in theme parks highlights the importance of experiential learning in enhancing visitors' satisfaction and perceived value, which resonates with the positive impact of the hands-on learning experience at Gili Sulat on the students' skills and understanding of marine ecosystems (Wu et al., 2018).

Moreover, the research on mangrove tourism by Kurniawansyah et al. (2022) provides valuable insights into the suitability of mangrove ecosystems in specific districts, emphasizing the importance of understanding the ecological aspects of such environments. This supports the notion that the hands-on learning experience at Gili Sulat contributes to students' understanding of marine ecosystems, as it allows them to engage directly with the ecological aspects of mangrove environments, thus enhancing their practical knowledge and skills (Kurniawansyah et al., 2022).

- ***Encounters with flora and fauna***

Student K (S-K) responses regarding encounters with flora and fauna during a visit to Gili Sulat are as follows.

> *"We encountered a variety of flora and fauna during our visit, including different species of mangroves like Rhizophora mucronata and Avicennia marina, as well as marine life such as the blue crab and various fish species. These encounters were educational, helping us to identify and understand the significance of each species within the ecosystem."*

The encounter with a diverse range of flora and fauna during the visit to Gili Sulat provided the students with an educational experience, enabling them to identify and understand the significance of each species within the ecosystem. The students' ability to recognize and appreciate various species, such as Rhizophora mucronata, Avicennia marina, blue crab, and various fish species, reflects their attention to detail and understanding of the key components of the mangrove ecosystem (Verawati & Idrus, 2023). This aligns with the notion that ecotourism experiences contribute to biodiversity literacy, as emphasized by Butarbutar and Pollo (2020). The ability to recognize and appreciate various species indicates a successful transfer of knowledge during their visit to Gili Sulat.

Furthermore, the research conducted around Gili Sulat has identified 53 species of reef fish belonging to 17 families, indicating the rich biodiversity of the marine life in the region (Gelis et al., 2021). The ability to encounter and comprehend such diverse flora and fauna is essential for promoting biodiversity literacy, which is crucial for understanding and conserving ecosystems (Waty-Hiola et al., 2023). The encounter with various species of mangroves, marine life, and reef fish in Gili Sulat also highlights the potential for mangrove ecotourism to serve as an educational and learning facility, particularly for students studying biology and related fields (Verawati & Idrus, 2023). Additionally, the carbon content potential of mangrove species in Gili Sulat, East Lombok, further underscores the ecological significance of these ecosystems, providing valuable insights into the role of mangroves in carbon sequestration and climate change mitigation (Diniyatushoaliha et al., 2023). Therefore, encounters with diverse flora and fauna in ecotourism sites like Gili Sulat not only contribute to biodiversity literacy but also offer practical learning opportunities for understanding the ecological functions and conservation value of these ecosystems (Paradise & Bartkovich, 2021).

- ***Inspiration for environmental protection***

Student M (S-M) responses regarding Inspiration for environmental protection are as follows.

> *"Visiting Gili Sulat was deeply inspiring, reinforcing my commitment to environmental protection. Witnessing the beauty and fragility of the mangrove ecosystem firsthand has motivated me to advocate for conservation efforts and sustainable practices more passionately."*

The student's experience of feeling more inspired and committed to environmental protection after visiting Gili Sulat aligns with the literature on environmental protection and sustainable development. Ecotourism experiences, such as visiting Gili Sulat, have been shown to evoke a sense of responsibility and commitment to environmental protection,

considering the interconnectedness of environmental health and human actions (Hadiprayitno et al., 2014). Additionally, the literature supports the idea that firsthand experiences in natural environments, such as mangrove ecosystems, can lead to a greater appreciation for the environment and a stronger commitment to its protection (Kumar & Ghodeswar, 2015). Furthermore, research in the field of biology has highlighted the need to better understand the interaction between population declines and environmental contaminants, emphasizing the importance of individual and collective efforts in environmental conservation. However, it does not directly support the claim about the student's experience (Stark et al., 2004). Moreover, studies have unveiled environmental passion and autonomous motivation as underlying mechanisms that account for the link between transformational leadership and pro-environmental behaviors, emphasizing the role of leadership in inspiring environmental commitment and action (Li et al., 2020).

The literature provides a comprehensive understanding of the factors influencing individuals' commitment to environmental protection, ranging from personal experiences in natural environments to the mediating roles of environmental passion and autonomous motivation under specific leadership styles. These findings underscore the multifaceted nature of environmental inspiration and the interconnectedness of individual attitudes, leadership, and environmental conservation efforts. The synthesis of these references supports the student's experience and highlights the diverse influences that contribute to environmental commitment and advocacy.

- ***Suggestions for improvement in educational facilities***

Student O (S-O) responses regarding suggestions for improvement in educational facilities in the Gili Sulat area are as follows.

> *"While the visit was highly educational, adding more interpretive signs and educational materials about the species and ecosystem processes could enhance the learning experience. Interactive activities or guided tours focusing on conservation efforts and the ecological importance of mangroves would also be beneficial."*

The proposal to enhance the educational experience in the Gili Sulat ecotourism area by incorporating interpretive signs, educational materials, and interactive activities is supported by relevant research. Allard et al. (2020) emphasize the urgent need for research to understand microbe-mangrove interactions that maintain ecosystem services and resilience, highlighting the importance of such initiatives for successful conservation and rehabilitation efforts. Additionally, Feller et al. (2017) provide insights into the state of the world's mangroves in the 21st century under climate change, highlighting recent reductions in net mangrove area losses, which underscores the significance of the suggested improvements in educational facilities to raise awareness about the importance of mangroves and their conservation in the face of environmental challenges. Furthermore, the recommendation for guided tours focusing on conservation efforts and the ecological importance of mangroves is supported by the work of (Eddy et al., 2021), which emphasizes the anthropogenic drivers of mangrove loss

and associated carbon emissions, providing valuable insights that can guide future restoration efforts. Additionally, the study by Purwoko et al. (2023) assesses the carrying capacity of mangroves as raw materials for culinary products, highlighting the importance of understanding the abundance of mangrove species for various uses, thus emphasizing the significance of educational initiatives that raise awareness about sustainable practices and the conservation of mangroves. Therefore, the proposed improvements in educational facilities efforts align with the urgent need to understand, protect, and rehabilitate mangrove ecosystems, making them crucial for successful conservation and restoration.

- ***Willingness to revisit for educational activities***

Student P (S-P)'s response regarding their willingness to return for educational activities to the Gili Sulat ecotourism area is as follows.

> *"I am definitely interested in revisiting Gili Sulat for further educational activities. The island offers a unique learning environment that combines natural beauty with ecological importance. Future visits could provide deeper insights and a greater appreciation of the complexities of coastal ecosystems."*

The desire to revisit Gili Sulat for educational activities is supported by the literature on mangrove ecotourism highlighting the importance of mangroves in Indonesia, considering their ecological significance and carbon storage capacity (Hilyana & Rahman, 2022). This aligns with the student's interest in revisiting Gili Sulat for educational activities, as it indicates a deeper understanding of the ecological importance of the island. Furthermore, Setiawan et al. (2017) discussed the development of ecotourism to preserve mangrove conservation efforts, emphasizing the positive impact of sustainable tourism experiences in creating lasting memories and impressions (Setiawan et al., 2017). This supports the idea that future visits to Gili Sulat could provide deeper insights and a greater appreciation of the complexities of coastal ecosystems, as the enduring educational value associated with mangrove ecotourism is recognised.

Moreover, the research by Harto et al. (2021) emphasizes the importance of developing mangrove ecotourism based on local wisdom, which includes increasing participation and empowerment of the local community. This resonates with the student's interest in revisiting Gili Sulat for educational activities, as it indicates the potential for meaningful engagement with the local community to gain insights into the ecological and cultural significance of the island. Additionally, the study by Titisari et al. (2022) focused on the management strategies of mangrove biodiversity and the role of sustainable ecotourism in achieving development goals, highlighting the potential for developing a sustainable mangrove ecotourism strategy to increase the value of Sustainable Development Goals (SDGs) (Titisari et al., 2022). This supports the idea that future visits to Gili Sulat for educational activities could contribute to sustainable development goals through the promotion of ecotourism and environmental education.

The educational visit to the mangroves of Gili Sulat offers students a comprehensive learning experience encompassing ecological, cultural, and socioeconomic dimensions. The visit allows students to observe and understand the unique adaptations of mangrove ecosystems, such as intricate root systems that serve as nurseries for marine life, fostering a deeper understanding of coastal environments (Rivera-Monroy et al., 2017). Furthermore, students gain insights into the interconnectedness of mangroves, seagrasses, and coral reefs, providing a holistic perspective on marine ecosystems and the symbiotic relationships between these habitats (Hilmi et al., 2023). Engaging in activities such as species identification and environmental monitoring fosters a connection between theoretical knowledge and real-world application, contributing to a deeper understanding of the diverse flora and fauna within the mangrove ecosystem (Getzner & Islam, 2020).

Moreover, the visit to Gili Sulat provides an opportunity for students to explore the cultural and socioeconomic dimensions of sustainable tourism, witnessing collaborative efforts in fisheries and ecotourism development and gaining insights into the delicate balance between environmental conservation and the well-being of local communities (Ellison et al., 2020). This immersive experience instills lasting memories and impressions that contribute to students' understanding of ecological systems and the importance of responsible tourism practices (Allard et al., 2020).

The educational visit to Gili Sulat aligns with the urgent need for research to uncover the microbe-mangrove interactions that maintain ecosystem services and resilience under changing conditions, making the study of mangrove microbiome functions a high priority (Rog et al., 2017). Additionally, the visit provides a platform for students to understand the critical importance of mangrove ecosystems for terrestrial vertebrates, as mangroves are used by a remarkable number of terrestrial mammal, reptile, and amphibian species (Sidik et al., 2018). Furthermore, the excavation of mangroves may involve significant disturbance to carbon pools, highlighting the importance of mangrove conservation for climate change mitigation (Henri et al., 2022).

The educational visit to Gili Sulat offers students a rich and immersive learning experience, encompassing ecological, cultural, and economic dimensions. It provides a unique opportunity for students to gain firsthand insights into the ecological intricacies of coastal environments, the interconnectedness of marine ecosystems, and the delicate balance required for the coexistence of ecosystems and human activities.

CONCLUSION

This study on Gili Sulat's mangrove ecotourism demonstrates its profound impact on enhancing environmental stewardship and education among students. Through firsthand experiences in a unique learning environment that combines natural beauty with ecological importance, students gained deeper insights into the complexities of coastal ecosystems. The research findings underscore the effectiveness of mangrove ecotourism in fostering a comprehensive understanding of ecological, cultural, and socioeconomic dimensions, thereby contributing to the cultivation of an environmentally knowledgeable and responsible

populace. The study validates the transformative potential of mangrove ecotourism as a dynamic platform for environmental education and experiential learning, highlighting its role in promoting sustainable development and conservation efforts.

LIMITATION

Despite its contributions, this study acknowledges several limitations. The research was confined to a specific demographic of fifth-semester Biology Education students, which may limit the generalizability of the findings to a broader population. The reliance on self-reported data through questionnaires and interviews may also introduce bias or inaccuracies in the representation of participants' experiences and perceptions. Additionally, the study's scope was limited to the educational impact of mangrove ecotourism in Gili Sulat, potentially overlooking other significant factors such as long-term behavioral changes in environmental stewardship among participants or the socioeconomic impacts on the local community.

RECOMMENDATION

Based on the study's findings, several recommendations are proposed to enhance the educational and conservation outcomes of mangrove ecotourism. First, expanding the demographic scope of future research to include a wider range of participants can provide a more comprehensive understanding of mangrove ecotourism's impacts. Implementing longitudinal studies would also be beneficial to assess the long-term effects of ecotourism experiences on environmental stewardship behaviors. Furthermore, it is recommended to develop and integrate more interactive and interpretive educational materials and activities within mangrove ecotourism sites to enrich learning experiences. Strengthening community involvement and collaboration in ecotourism projects can further ensure the sustainability and effectiveness of conservation efforts. Lastly, advocating for policy frameworks that support the balance between conservation needs and socioeconomic development is crucial for the sustainable advancement of mangrove ecotourism.

Author Contributions

The authors have sufficiently contributed to the study, and have read and agreed to the published version of the manuscript.

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Conflict of interests

The authors declare no conflict of interest.

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