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The potential of the Malabot Tumpe ethnobiology-containing e-module in realizing sustainable biodiversity conservation

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Abstract

Malabot Tumpe is local wisdom which has the meaning of realizing the 15th SDG goal in the conservation of maleo birds. Concepts such as ecosystem balance and biodiversity, which are reflected in Malabot Tumpe traditional practices, indicate the potential for Malabot Tumpe in integrating biology learning material, especially biodiversity material. The integration of values or knowledge from local wisdom containing ESD can be integrated into biology learning through e-modules. However, so far, there has been no research that specifically discusses the integration of Malabot Tumpe local wisdom, which contains sustainable conservation values, into biology learning. For this reason, the author aims to reveal the potential of e-modules containing Malabot Tumpe local wisdom as a form of implementing ESD in extracurricular biology learning activities in schools. The method used was a systematic literature review with a sample of 12 international and national articles. The result of this study is that there is potential for an E-module containing Malabot Tumpe local wisdom to not only help students achieve learning goals but also help sustainably preserve biodiversity. However, further research is needed to empirically measure the effectiveness of the Malabot Tumpe ethnobiology e-module and its impact on ESD to achieve sustainable biodiversity.

Abstrak. *Malabot Tumpe merupakan kearifan lokal yang mempunyai makna mewujudkan tujuan ke-15 SDGs dalam konservasi burung maleo. Konsep-konsep seperti keseimbangan ekosistem dan biodiversitas yang tercermin dalam praktik adat Malabot Tumpe mengindikasikan adanya potensi Malabot Tumpe dalam integrasi materi pembelajaran biologi khususnya materi keanekaragaman hayati. Integrasi nilai-nilai atau pengetahuan dari suatu kearifan lokal yang bermuatan ESD dapat diintegrasikan ke dalam pembelajaran biologi melalui e-modul. Namun sejauh ini belum ada penelitian yang secara khusus membahas integrasi kearifan lokal Malabot Tumpe yang mengandung nilai-nilai konservasi secara berkelanjutan, ke dalam pembelajaran biologi. Untuk itu penulis bertujuan ingin mengungkap bagaimana potensi e-modul bermuatan kearifan lokal Malabot Tumpe sebagai bentuk implementasi ESD dalam kegiatan intrakurikuler pembelajaran biologi di sekolah. Metode yang digunakan adalah tinjauan literatur sistematis dengan 12 sampel artikel internasional dan nasional. Hasil dari kajian ini adalah adanya potensi E-modul yang memuat kearifan lokal Malabot Tumpe tidak hanya membantu siswa mencapai tujuan pembelajaran tetapi sekaligus membantu pelestarian biodiversitas secara berkelanjutan. Namun dibutuhkan penelitian lebih lanjut untuk mengukur efektivitas e-modul bermuatan tetnobiologi Malabot Tumpe dan dampaknya terhadap ESD untuk mencapai biodiversitas yang berkelanjutan secara empiris.*

A. Introduction

Indonesia, as one of the mega biodiversity countries in the world, offers rich and unique habitats for various species of flora and fauna. According to National Geographic Indonesia (2019) Indonesia ranked second in the terrestrial biodiversity category after Brazil. Still, if terrestrial biodiversity is added to marine biodiversity, Indonesia become the country with the highest biodiversity in the world (Setiawan, 2022). Indonesia has high fauna diversity, specifically 115 species of mammals, 1,500 species of birds, 600 species of reptiles, 270 species of amphibians, and 1247 species of fishes (Mubarik et al., 2022). Among the terrestrial and aquatic fauna in Indonesia, some are endemic fauna that are only found in Indonesia (IUCN, 2020; KLHK, 2019).

One of the endemic animals typical of the Wallacea ecosystem is the maleo bird (*Macrocephalon maleo*). The Maleo bird is one of the endemic animals of Sulawesi which is spread across North Sulawesi, South Sulawesi, Southeast Sulawesi, and Central Sulawesi. As one of the endemic birds of Sulawesi, the maleo bird is not only an integral part of local biodiversity but also an icon of pride and cultural heritage that is preserved from generation to generation. This is proven by the Minister of Environment and Forestry Regulation Number P.106/Menlhk/Setjen/Kum.1/12/2022 concerning Protected Types of Plants and Animals, which explicitly explains that maleo birds receive legal protection. However, currently, the maleo bird is listed on the IUCN red list as an endemic animal that is threatened with extinction (Gonibala et al., 2022; Karim et al., 2022; Santrio et al., 2021). The maleo bird population faces serious threats due to habitat degradation and fragmentation, egg exploitation, and illegal hunting of maleo bird parents (Nurhani & Sifatu, 2018; Wantogia et al., 2024; Yusuf et al., 2024).

The problem regarding the status of the maleo bird, which is threatened with extinction, requires serious efforts to ensure its existence continues to be maintained. Efforts to preserve the maleo bird in Sulawesi do not only rely on legal regulations that bind it but also through conventional strategies carried out by the local community through a traditional tradition that has been carried out for generations known as Malabot Tumpe. Malabot Tumpe is a traditional tradition of the Banggai people in Central Sulawesi which marks the start of the maleo egg harvest season through a series of conventional processions of delivering maleo bird eggs wrapped in palm leaves from the Bosanyo traditional house to the Banggai palace (Karim et al., 2022; Nurham et al., 2018; Samathan et al., 2021). People are only allowed to enjoy or consume maleo bird eggs when the Malabot Tumpe traditional ceremony is being held. Outside of that people are prohibited by custom (Nurhani & Sifatu, 2018). Knowing this conventional procession, if studied scientifically the aim of the Malabot Tumpe tradition is as a form of conservation of the maleo bird. Malabot Tumpe, as one of the local wisdoms of the Banggai people, is considered effective in preserving maleo birds. This is as stated by Nurhani & Sifatu (2018), who stated that the maleo conservation program strategy carried out by the Wildlife Conservation Society-Indonesia Program (WCS-IP) and Wildlife and Animal Conservation by involving local communities is more effective than one-way conservation, which only consists of the government.

Concepts such as ecosystem balance and biodiversity are reflected in Malabot Tumpe's traditional practices. This indicates the potential for Malabot Tumpe's local wisdom in integrating biology learning materials. Unfortunately, this is not yet known by biology teachers in Banggai Regency and its surroundings, so it has not been utilized in classroom learning. Teachers need a deep understanding of local culture and traditions, so this can trigger teacher creativity in preparing learning materials and strategies that are relevant and interesting for students. Apart from that, the Malabot Tumpe tradition, which has a special meaning in the conservation of maleo birds, is indirectly a form of implementation in achieving the 15th goal of sustainable development (SDGs), which specifically aims at target 15.5, namely stopping the loss of biodiversity, as well as protecting and preventing the disappearance of species which is threatened with extinction. Thus, apart from being a cultural heritage that needs to be preserved, the Malabot Tumpe tradition is also a form of effort to achieve the 15th SDGs goal.

In Indonesia, sustainable development is a mandate from laws and regulations that must be implemented at all levels of society. So, it is hoped that in the future, development will not just be a policy but will also be carried out academically in the educational sphere (Fitriandari & Winata, 2021). Efforts to achieve SDGs through education are known as Education for Sustainable Development (ESD). Thus, schools as educational institutions play a central role in realizing the SDGs. This implementation can be done by integrating the principles of sustainable development into intracurricular activities according to the applicable curriculum. However, in reality, there are still many Indonesian biology teachers who do not fully understand ESD and how to integrate it into biology learning, resulting in learning not referring to environmental, social, or economic phenomena (Purwianingsih et al., 2022; Purwianingsih & Mardiyah, 2018; Saragih et al., 2021).

Seeing the potential of Malabot Tumpe's local wisdom in ESD can provide a solution for teachers who face difficulties in integrating ESD values into biology learning at school. This is as stated in Yasir & Hartiningsih (2023) that by utilizing local wisdom as learning material content about how local

communities sustainably adapt to their environment, they can instill ESD values in students. In this way, students, as the nation's next generation, will be equipped with ESD competencies, namely mindsets and attitudes that lead to considerations of present and future life (Anyolo et al., 2018; Saragih et al., 2021). In this case, the teacher's role is very important in facilitating students in contextual learning so that it can be correlated with the development of sustainable skills (life skills) based on the potential of local wisdom.

Knowledge and values contained in local wisdom can be integrated into biological material with the help of modules (Adinugraha & Ratnapuri, 2020). The use of e-modules based on local wisdom develops 21st-century skills and enhances more meaningful learning experiences, as well as forming digitally literate students (Atmaja et al., 2021; Perwitasari & Akbar, 2018; Ridho et al., 2021). Seeing the potential of this e-module, the author wants to examine how an e-module containing Malabot Tumpe local wisdom, which emphasizes sustainable conservation, can be implemented in biology learning. What specifically refers to the biology learning achievements in the Merdeka Curriculum is that at the end of phase F, students can create solutions to problems based on local, national, and global issues related to understanding the diversity of living things.

So far, there has been no research that specifically discusses the integration of Malabot Tumpe's local wisdom, which contains sustainable conservation values, into biology learning. This indicates that the great potential of Malabot Tumpe's local wisdom has not been fully explored. For this reason, in this literature review, the author aims to reveal the potential of e-modules containing Malabot Tumpe local wisdom as a form of implementing ESD in extracurricular biology learning activities in schools. Furthermore, the author also thoroughly examines the integration of ESD values contained in the Malabot Tumpe tradition as well as key competencies that may emerge from the application of e-modules containing Malabot Tumpe local wisdom. Thus, it is hoped that the results of this study can become a basis for biology teachers in implementing an ethnoscience approach, especially the local wisdom of Malabot Tumpe, as well as applying ESD values to Biology learning.

B. Material and method

The method used in this research is a literature review by analyzing relevant international and national articles indexed by Scopus and SINTA and focusing on the topic of local wisdom of Malabot Tumpe as well as the integration of ESD values in biology learning. The types of articles used in this literature review were obtained through Harzing's Publish or Perish software using the Google Scholar, Scopus, Crossref, and Semanticscholar databases by entering keywords, namely ESD, biology learning, Malabot Tumpe, biodiversity conservation, and e-module. By using a purposive sampling technique, 12 samples were obtained in the form of Scopus and SINTA-indexed journal articles discussing the local wisdom of Malabot Tumpe and biology learning containing local wisdom integrated with ESD from 2019 to 2024 (see Table 1).

Table 1 Empirical study of Malabot Tumpe research and biology learning containing local wisdom integrated with ESD

No	Author(s)	Research Focus	Result
1	Karim et al. (2022)	Values of Malabot Tumpe	The values of prosperity and peace.
2	Lamadang & Supriatna (2021)	Educational values of Malabot Tumpe	Educational values of Malabot Tumpe that can be applied in strengthening the character of students.
3	Familu & Lamadang (2023)	Social values of Malabot Tumpe	The social values of Malabot Tumpe consist of nature conservation behavior and life guidelines, as well as interaction processes.
4	Nurhani & Sifatu (2018)	Implementation of Malabot Tumpe	Conservation of maleo birds through Malabot Tumpe.
5	Szombathy (2021)	Ethnography of Malabot Tumpe traditional rituals	Malabot Tumpe means preserving the maleo bird.
6	Hasanah (2023)	Cultural values of Malabot Tumpe	Malabot Tumpe is not widely known to the local community.
7	Adinugraha & Ratnapuri (2020)	Module containing local wisdom	Modules containing local wisdom make it easier for students to understand the material.
8	Ridho et al. (2021)	E-module containing local wisdom	Digital books containing local wisdom improve students' critical thinking skills.
9	Li et al. (2023)	Module containing local wisdom	Modules with a local wisdom approach are effective in improving student learning outcomes.
10	Perwitasari & Akbar (2018)	E-module containing local wisdom	Modules with a local wisdom approach are effectively used in learning.
11	Atmaja et al. (2021)	E-module containing local wisdom	Modules with a local wisdom approach are effectively used in learning.
12	Insani et al. (2023)	Modul based on ESD	ESD-based interactive e-module is effectively used in learning.

The literature review used in the research follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines developed by Page et al. (2021). The procedure consists of identification, screening, and inclusion stages. In the identification stage, the researcher defined the research question clearly and specifically, namely regarding the local wisdom of Malabot Tumpe and the integration of ESD values into biology learning. Then, proceed with searching for samples of research articles using Harzing's Publish or Perish software. In this stage, the author uses a year limit from 2019 to 2024. This is intended to ensure the inclusion of the latest information, accommodate changes in paradigms, methods, and new concepts, as well as focus the study on current challenges and problems in the research field. The articles that have been found are then summarized into tables to organize the extracted data, complete with bibliographic information. At the screening stage, duplicate articles were removed, and initial screening was carried out on titles and abstracts that were irrelevant or did not meet the predetermined inclusion criteria. Then, a full-text review is carried out, and an article quality assessment is carried out to see whether the article has a significant risk of bias or not. The inclusion stage continues by including articles that meet all inclusion and exclusion criteria and have adequate methodological quality.

C. Results and discussion

Malabot Tumpe local wisdom

Malabot Tumpe is one of the local wisdoms in Banggai Regency, Central Sulawesi, in the form of a series of activities that mark the start of the maleo bird egg harvest season from Batui to the Banggai Laut Palace (Sczombathy, 2021). Malabot Tumpe is an annual tradition carried out in December when the first egg of the maleo bird is hatched (Samatan et al., 2021). Referring to Nurhani & Sifatu (2018); Karim et al. (2022), a picture of the Malabot Tumpe traditional procession can be seen in Figure 1.

The implementation of the Malabot Tumpe Tradition uses 100 maleo bird eggs, the use of which is limited to preserving the maleo bird. Eggs that are not used in traditional processions will be hatched for cultivating maleo bird eggs in the Batui area, Banggai district (Szombathy, 2021). The Batui area is located close to the Sigi district, one of the areas in Central Sulawesi, which has four hot springs, so the Batui area is exposed to geothermal heat (Wibowo et al. 2015). Maleo birds need geothermal heat and solar radiation to incubate their eggs. The unique maleo bird makes its habitat look unique, nesting in open sand areas and areas around beaches, volcanoes, and areas that are warm from geothermal heat or sunlight (Mustari, 2022). The maleo bird habitat can be developed as a tourist area so that it can provide income for managers to be able to preserve the maleo bird (Karim et al., 2020). Conservation can be carried out by preserving natural habitats, restoring and maintaining species populations, education to increase public awareness, empowering local communities, and protecting ecosystems (Khairina et al., 2020). Conservation efforts that involve community participation are key to maintaining Maleo's survival. Wildlife and Animal Conservation by involving local communities is seen as more effective than one-way conservation, which only involves the government to protect and preserve the habitat and maleo birds to avoid the threat of extinction (Angela, 2023; Wantogia et al., 2024).

The implementation of the Malabot Tumpe tradition is also held at the same time as the Tumpe Festival. The Tumpe Festival is a forum for introducing maleo birds and promoting tourism potential, as well as reminding the wider community of the importance of protecting maleo birds (Hasanah, 2023; Familu & Lamadang, 2023). Maelo birds can be used as ecotourism by creating a bird tourism gate and creating photo spot tourism using the concept of natural panoramas (Subuh & Musae, 2019).

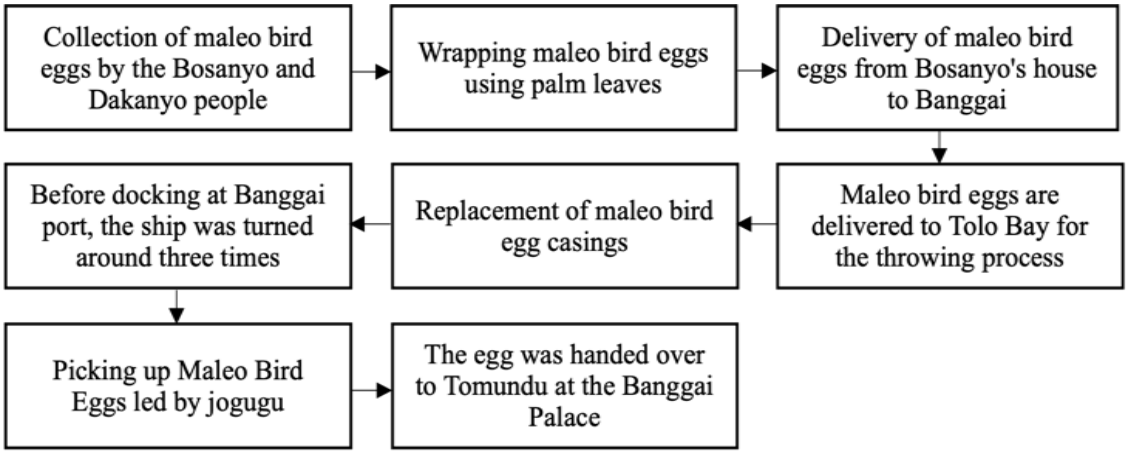

Figure 1 Malabot Tumpe traditional procession series

The 2022 Tumbe Festival also carries a thematic concept, namely Tourism, Historical, environmental, and maritime culture. This activity involves the government, community, and also students in Banggai Regency. During the Tumpe Festival, various activities were carried out to increase public awareness about the endangered maleo bird (Dinas Pariswisata dan Kebudayaan Banggai Laut, 2022). Malabot Tumpe Festival became a Conservation Awareness medium in the form of an environmental campaign to save the habitat of the Maleo Bird as a protected and endemic animal of Sulawesi Island. Based on this traditional procession, the Malabot Tumpe tradition contains the meaning of conservation efforts for the maleo bird as an endemic bird of Sulawesi (Karim et al., 2022; Lamadang & Supriatna, 2021). Carrying out this custom, it becomes a mediua for education about the importance of the existence of the maleo bird. Also, it provides direction for carrying out the breeding of some of the eggs that have been handed over (Szombathy, 2021).

ESD Values in Malabot Tumpe Local Wisdom

ESD is an effort to achieve the SDGs through education. ESD (Educational for Sustainable Development) is a learning process that is based on the goals and principles that underlie sustainability and reduce dependence on the environment and society (Chin et al., 2019; Rieckmann, 2017). Thus, ESD becomes an important means for achieving the SDGs because it provides the foundation of knowledge and skills necessary for individuals to contribute to achieving the SDGs goals (Insani et al., 2023). Through ESD, students can develop problem-solving and critical thinking skills needed to create positive change in sustainable development (Agusti et al., 2019; Inayah et al., 2023).

The application of ESD principles can be integrated by highlighting the local wisdom of a region, one of which is the local wisdom of the Malabot Tumpe tradition in Central Sulawesi, which has the aim of conserving the maleo bird. Knowing this, the local wisdom of Malabot Tumpe is a form of effort made by the Banggai people of Central Sulawesi to realize the 15th SDGs goal. The goal of the 15th SDGs is to protect, restore, and increase the sustainable use of terrestrial ecosystems, manage forests sustainably, stop desertification, reverse land degradation, and stop the loss of biodiversity (Bapennas, 2022). This supports Khairina et al. (2020) that achieving the 15th SDGs goal is through conservation, which can be done by preserving natural habitats, restoring and maintaining species populations, education to increase public awareness, empowering local communities, and protecting the ecosystem.

Habitat conservation can involve the community by protecting the habitat where a species breeds. One way to restore and maintain species can be done by protecting bird nests so that populations can be maintained (Maduriana, 2021). This contributes to global efforts to halt the decline in biodiversity and recover endangered species. Through the Malabot Tumpe tradition, we can provide education to the public regarding the importance of nature conservation and species conservation. Maleo bird conservation maintains the sustainability of terrestrial ecosystems and reduces widespread environmental damage.

Rieckmann (2017) explains that there are three pillars of ESD: social, economic, and environmental. However, as a rule of law country, Indonesia integrates legal pillars in the implementation of ESD. So, in this paper, the author tries to explain the integration of ESD values contained in the Malabot Tumpe tradition into four pillars: social, economic, environmental, and legal. In the social aspect, the Malabot Tumpe tradition has two values, namely strengthening identity and solidarity and social welfare. This is as stated in Brata (2016); Suyatno (2016), that local wisdom is often the core of the identity of a community. In the procession, the community works together, from collecting the eggs to handing over the maleo bird eggs to the indigenous community. Values, stories, and traditions that are preserved from generation-to-generation help maintain a sense of solidarity among community members and become the identity of the local community. In this way, social welfare will be realized.

In the economic aspect, the Malabot Tumpe tradition has two ESD values, namely increasing the income of the local community because of the potential for ecotourism from breeding maleo birds. This is in line with Rahim et al. (2022) that ecotourism allows local communities to develop various sources of income, including local accommodation, skills as guides, and handicrafts. Meanwhile, for the environmental aspect, the Malabot Tumpe tradition has two ESD values, namely habitat management and the role of the maleo bird in maintaining ecosystem balance. Habitat management can be done by creating a nursery to protect the area where the maleo bird breeds and planting trees around the maleo bird's habitat. Management of the maleo bird's habitat is important, apart from maintaining its existence, but also considering the important role of the maleo bird for nature. Maleo birds can maintain ecosystem balance, help spread seeds, and regenerate forests (Karim et al., 2020). Considering human dependence on nature, through the Malabot Tumpe tradition, awareness is given to the public about the importance of the maleo bird for the ecosystem. So apart from preserving maleo birds, the community also takes part in protecting nature.

The important role of maleo birds for the environment and human life itself means that the government provides legal protection for maleo birds as written in Minister of Environment and Forestry Regulation Number P.106/Menlhk/Setjen/Kum.1/12/2022 concerning Protected Plant and Animal Types. Apart from law enforcement, the government also

takes part in monitoring the law regarding the conservation of maleo birds. The authorities do this by ensuring that there are no human actions that damage the maleo bird's habitat and carry out hunting.

Integration of ESD through Malabot Tumpe in Biology Learning

The Merdeka Curriculum is a form of embodiment of the idea of a more flexible and comprehensive education so that students have a relevant and comprehensive learning experience. The Merdeka Curriculum emphasizes that learning must be oriented towards a sustainable life. This is a form of the Indonesian government in realizing the SDGs through ESD. There are no special subjects in schools that study ESD in detail. However, ESD values can be integrated into all subjects, including biology (Indrati & Hariadi, 2016). The Pancasila student profile, as a form of translating the objectives of the Merdeka Curriculum becomes a reference for teachers in building student character and competence (Bariroh et al., 2023). The Pancasila student profile consists of six dimensions, namely: 1) faith, devotion to God Almighty, and noble character, 2) independence, 3) cooperation, 4) global diversity, 5) critical reasoning, and 6) creativity (Badan Standar Kurikulum dan Asesmen Pendidikan, 2022). The global diversity dimension is an effort to preserve noble culture, identity, and locality, as well as remaining open to interacting with other cultures to be able to instil an attitude of tolerance that does not violate the ancestral culture of the Indonesian people (Nurgiansah, 2022; Wijayanti & Muthali'in, 2023). In this case, it means that introducing or highlighting local wisdom in learning is part of implementing the Pancasila student profile in schools. In this way, local wisdom can be used as a student learning resource (Alimah, 2019).

One of the learning achievements of biology subjects in phase E is that students can create solutions to problems based on local, national, and global issues related to understanding the diversity of living things. By highlighting the local wisdom of the Malabot Tumpe tradition, students will gain knowledge about sustainable biodiversity conservation against the extinction of the maleo bird as one of the endemic animals that are currently threatened with extinction. In this way, students will construct knowledge about how efforts can be made to protect and preserve biodiversity and the environment. Apart from that, the Malabot Tumpe traditional tradition as an effort to conserve the maleo bird is also a form of realization of the 15th goal of the SDGs, namely target 15.5, taking immediate and significant action to reduce degradation of natural habitats, stop the loss of biodiversity, and protect and prevent the disappearance of endangered species.

In the learning process, teaching materials or modules are needed. E-modules are a form of digital learning that can be adapted to student needs and allow easy access from various electronic devices such as computers, tablets or smartphones (Insani et al., 2023). The existence of e-modules, apart from being relevant for developing students' digital literacy, also makes it easier for students to understand the material better (Atmaja, 2021; Insani et al., 2023; Pratiwi et al., 2021). Furthermore, Li et al. (2023) explained that e-modules containing local wisdom were effective in improving student learning outcomes, especially in biodiversity material. Thus, after knowing the values of Malabot Tumpe's local wisdom, which leads to the sustainable conservation of maleo birds, it can be integrated into biology learning, especially Phase E, with the help of e-modules.

Structurally, the e-module containing ethnobiology in Malabot Tumpe will focus on biodiversity material in phase E, with material coverage such as basic material concepts, the value and benefits of biodiversity, as well as its damage and conservation. Apart from that, the e-module will also include the Malabot Tumpe tradition as well as information on the meaning of this tradition. Here, students will also be given cases related to the destruction and threats to biodiversity in Indonesia. So that students are motivated to preserve and provide simple alternatives that can be done. Student actions to realize sustainable conservation in this module take the form of invitations, such as an invitation to plant trees. Planting trees is not only a movement to green the earth but also provides habitat for other species, such as maleo birds. The next action is to join a conservation community on social media and around where the students live. In this way, students will gain new knowledge about the importance of protecting nature and how conservation efforts are carried out. The last student action was to campaign for their learning results on social media in the form of posters or videos. This is intended so that all elements of society who see it are aware and participate in preserving the environment.

ESD Key Competences

ESD is directed at supporting the potential of each individual through real action, considering the environmental, social and economic impacts, both now and in the future, from various perspectives (Rieckmann, 2017). ESD has 8 key competencies that students must have to increase creativity, find solutions, and develop their activities for sustainable development (Misriani et al., 2023). Two of the eight competencies that are important for students to have been systems thinking and self-awareness. When students have good systems thinking skills, they will understand the content well even if they don't study it specifically, but not vice versa (Meilinda et al., 2018). Meanwhile, self-awareness is the belief that a person has in understanding, accepting and controlling all possible developments in life in the future (Purnawati et al., 2023). Self-awareness is the awareness to

practice a sustainable lifestyle in living life so that sustainable development goals can be achieved (Amelia & Chandra, 2020).

The e-module containing Malabot Tumpe's local wisdom on biodiversity material has the potential to build students' systems thinking abilities. The e-module, which contains local aspects rich in traditional knowledge and practices, not only teaches about environmental conservation but also invites students to understand the complex relationship between humans and nature (Firmansyah et al., 2023). By deeply understanding the ecological and social systems involved in the conservation activities contained in Malabot Tumpe, students learn to consider the impact of each action on the ecosystem as a whole, stimulating a systemic mindset that is essential in facing today's global environmental challenges. Thus, this e-module is not only an instrument for maintaining environmental sustainability but also builds a strong foundation for students to become agents of change who are aware of the importance of harmony between humans and nature.

E-modules that integrate local wisdom from Malabot Tumpe in an effort to realize sustainable conservation, apart from having the potential to build students' thinking systems, can also build students' self-awareness abilities. Even though students are already familiar with this tradition, this e-module will present in detail the Malabot Tumpe procession so that students know the meaning behind all the processions carried out. The description of this e-module will also be equipped with reflections so that students are more aware of their role in protecting ecosystems and cultural heritage. This process triggers deep reflection on the relationship between individual actions and their impact on the environment and society. By becoming more aware of their role in conservation, students develop greater self-awareness about their values and behavior towards the environment. This ability not only impacts their actions in building a sustainable life but also shapes their character as global citizens who are responsible and care about natural and cultural heritage. Thus, this module not only provides knowledge about conservation but also becomes a catalyst for students' personal growth in building sustainable self-awareness.

D. Conclusion

We have reviewed articles that focus on the local wisdom of Malabot Tumpe in sustainable conservation efforts as well as the integration of ESD in biology learning with the help of e-modules. The articles reviewed show that the use of e-modules containing Malabot Tumpe local wisdom in biology learning, especially biodiversity material, has the potential to realize the 15th SDGs goal. Findings from various sources show that approaches that combine traditional knowledge with digital technology can increase public awareness of the importance of conserving biodiversity. By providing easy and fun access to ethnobiology, e-modules enable stronger collaboration between researchers, environmental information activists, and local communities in environmental conservation efforts. Based on the results of studies that have been carried out, this e-module also has the potential to develop students' thinking systems and self-awareness. However, it is recommended that future researchers measure the direct impact of using this e-Module on students and local communities regarding conservation behavior. Apart from that, further research needs to be carried out to determine the effectiveness of this e-module in biology learning and its impact on ESD to achieve the SDGs. Thus, it is hoped that further research will provide deeper insight into the potential and practical application of the e-module containing Malabot Tumpe ethnobiology in an effort to realize sustainable biodiversity conservation.

E. References

Adinugraha, F., & Ratnapuri, A. (2020). Modul keanekaragaman hayati dengan pendekatan kearifan lokal dan budaya di Kabupaten Purworejo. *Susunan Artikel Pendidikan*, *5*(1), 26-33. DOI: https://doi.org/10.30998/sap.v5i1.6534

Agusti, K. A., Wijaya, A. F. C., & Tarigan, D. E. (2019). Problem based learning dengan konteks ESD untuk meningkatkan keterampilan berpikir kritis dan sustainability awareness siswa SMA pada materi pemanasan global. In *Prosiding Seminar Nasional Fisika (E-jorunal),* (Vol. 3, pp. 175-182). DOI: https://doi.org/10.21009/03.SNF2019.01.PE.22

Alimah, S. (2019). Kearifan lokal dalam inovasi pembelajaran biologi: Strategi membangun anak indonesia yang literate dan berkarakter untuk konservasi alam. *Jurnal Pendidikan Hayati, 5*(1), 1-9. DOI: https://doi.org/10.33654/jph.v5i1.574

Amelia, A., & Chandra, A. F. (2020). Karakteristik instrumen non-tes sustainability awareness menggunakan analisis rasch model materi pemanasan global untuk siswa sekolah menengah. *Wahana Pendidikan Fisika*, 5(2), 49–56. DOI: https://doi.org/10.17509/wapfi.v5i2.27431

Angela, V. F. (2023). Strategi pengembangan ekowisata dalam mendukung konservasi alam Danau Tahai. *JIM: Jurnal Ilmiah Mahasiswa Pendidikan Sejarah*, *8*(3), 984-993. DOI: https://doi.org/10.24815/jimps.v8i3.24980

Anyolo, E. O., Kärkkäinen, S., & Keinonen, T. (2018). Implementing education for sustainable development in Namibia: School teachers' perceptions and teaching practices. *Journal of Teacher Education for Sustainability*, *20*(1), 64-81. DOI: https://doi.org/10.2478/jtes-2018-0004

Atmaja, A. T., Nurul, M. & Akbar, S. (2021). Pengembangan e-modul berbasis kearifan lokal dan kecakapan hidup. *Jurnal Pendidikan: Teori,*

Penelitian, dan Pengembangan. 6(11). 1673-1678. DOI: https://doi.org/10.17977/jptpp.v6i11.15104

Badan Standar Kurikulum dan Asesmen Pendidikan. (2022). *Panduan pembelajaran dan asesmen*. Jakarta: Kementerian Pendidikan Kebudayaan Riset dan teknologi.

Bappenas. (2020). *Metadata indikator tujuan pembangunan berkelanjutan (TPB)/Sustainable development goals (SDGs) di Indonesia*. Jakarta: Kedeputian Bidang Kemaritiman dan Sumber Daya Alam, Kementerian Perencanaan Pembangunan Nasional/Badan Perencanaan Pembangunan Nasional.

Brata, I. B. (2016). Kearifan budaya lokal perekat identitas bangsa. *Jurnal Bakti Saraswati, 5*(1), 9-16. Retrieved from http://ojs.unmas.ac.id/index.php/Bakti/article/view/226

Chin, C. K., Munip, H., Miyadera, R., Thoe, N. K., Ch'ng, Y. S., & Promsing, N. (2019). Promoting education for sustainable development in teacher education integrating blended learning and digital tools: An evaluation with exemplary cases. *Eurasia Journal of Mathematics, Science and Technology Education*, *15*(1), 1–17. DOI: https://doi.org/10.29333/ejmste/99513

Dinas Pariwisata Pendidikan Kabupaten Banggai Laut. (2022). Petunjuk teknis kegiatan festival Tumbe 2022. Banggai. Banggai Laut, Sulawesi Tengah: DPPKBL. Retrieved from https://www.scribd.com/document/611800227/Juknis-Kegiatan-Festum-2022

Familu, F. & Lamadang, K. P. (2023, October). Actualization of social values in the implementation of the Mombowa Tumpe ceremony in the Batui Indigenous Communities, Banggai District. In *4th Borobudur International Symposium on Humanities and Social Science 2022 (BIS-HSS 2022),* (pp. 166-173). Atlantis Press. DOI: https://doi.org/10.2991/978-2-38476-118-0_19

Firmansyah, F., Hidayat, S., Leksono, S. M., & Jamaludin, U. (2023). Kearifan lokal dalam menjaga kelestarian lingkungan hidup di Cagar Alam Rawa Danau (CARD). *Biosfer: Jurnal Biologi dan Pendidikan Biologi*, *8*(1), 1-5. DOI: https://doi.org/10.23969/biosfer.v8i1.8405

Fitriandari, M. & Winata, H. (2021). Manajemen pendidikan untuk pembangunan berkelanjutan di Indonesia. *Competence: Journal of Management Studies,* 15(1), 1-13. DOI: https://doi.org/10.21107/kompetensi.v15i1.10424

Gonibala, F. S., Martina, A. L., & Wawan, N. (2020). Perilaku burung maleo (Mecrocephalon Maleo) dewasa di penangkaran kawasan Taman Nasional Bogani Nani Wartabone. *Cocos, 13*(2), 1-8. DOI: https://doi.org/10.35791/cocos.v3i3.33181

Hasanah, N. (2023). Nilai budaya dalam upacara adat Malabot Tumpe: Studi refleksi upacara adat Tumpe Kecamatan Batui. *Journal of Tompotika: Social, Economics, and Education Science*, *1*(2), 135–143. Retrieved from https://jtsees.untika.ac.id/index.php/jtsees/article/view/52

Inayah, G. N., Rochintaniawati, D., & Sanjaya, Y. (2023). Analisis penggunaan media pembelajaran dan implementasi ESD yang digunakan guru biologi SMA/MA. *Jurnal Ilmiah Pekan Biologi, 9*(2), 24-34. DOI: https://doi.org/10.22437/biodik.v9i2.18834

Indrati, D. A., & Hariadi, P. P. (2016). ESD (education for sustainable development) melalui pembelajaran biologi. In *Symposium on Biology Education,* (Vol. 12, No. 2, pp. 371-382). Retrieved from http://symbion.pbio.uad.ac.id/prosiding/prosiding/ID_316_Dika%20Agustia%20Indrati_Revisi_Hal%20371-382.pdf

Insani, A. M., Ghullham, H., & Agnestia, R. P. (2023). Perangkat pembelajaran e-modul interaktif berbasis education for sustainable development topik konservasi tanaman herbal di sekolah dasar. Pendas. *Jurnal Ilmiah Pendidikan Dasar*, *8*(2), 2548-6950. DOI: https://doi.org/10.29303/abdiinsani.v10i4

IUCN. (2020). *The IUCN red list of threatened species*. Version 2020-2. Retrieved from https://www.iucnredlist.org

Karim, F. A., Julia, M., & Asrianti, A. (2022). The local wisdom of 'Malabot Tumbe': A community ritual in Banggai District. *Jurnal Kewarganegaraan, 6*(2), 2723-2328. DOI: https://doi.org/10.21043/quality.v10i2.17127

Karim, H. A., Najib, N. N., Darman, D., & Alam, A. (2020). Pendugaan populasi dan perilaku bertelur burung maleo (Macrochepalon Maleo) di Twa Danau Towuti Kabupaten Luwu Timur. *Journal of Forestry Research*, *3*(2), 99-114. DOI: https://doi.org/10.32662/gjfr.v3i2.1191

Kementerian Pendidikan kebudayaan Riset dan Teknologi. (2022). *Keputusan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia nomor 262/M/2022 tentang pedoman penerapan kurikulum dalam rangka pemulihan pembelajaran*. Jakarta.

Khairina, E., Purnomo, E. P., & Malawani, E. J. (2020). Sustainable development goals: Kebijakan berwawasan lingkungan guna menjaga ketahanan lingkungan di Kabupaten Bantul Daerah Istimewa Yogyakarta. *Jurnal Ketahanan Nasional, 26*(2), 155-181. DOI: https://doi.org/10.22146/jkn.52969

KLHK. (2019). *Panduan identifikasi jenis satwa liar dilindungi: Herpetofauna*. Kementerian Lingkungan Hidup dan kehutanan dan Lembega Ilmu Pengetahuan Indonesia. Retrieved from https://ksdae.menlhk.go.id/assets/publikasi/BUKU%20PANDUAN%20IDENTIFIKASI%20HERPETOFAUNA%20DILINDUNGI.pdf

Lamadang, K. P. & Supriatna, M. (2021). Value of education in Malabot Tumpe in Batui indigenous people of Banggai Regency. Advances in Social Science. *Education and Humanities Research*,

654(4), 10-13. DOI: https://doi.org/10.2991/assehr.k.220402.003.

Li, L., Hastuti, S. P., & Cahyaningrum, D. C. (2023). Pengembangan modul dengan pendekatan kearifan lokal pada materi keanekaragaman hayati. *Jurnal Pendidikan MIPA*, *13*(4), 1153-1161. DOI: https://doi.org/10.37630/jpm.v13i4.1304

Meilinda, M. Rustaman, N. Y., Firman, H., & Tjasyono, B. (2018, May). Development and validation of climate change system thinking instrument (CCSTI) for measuring system thinking on climate change content. In *Journal of Physics: Conference Series*, (Vol. 1013, No. 1, p. 012046). IOP Publishing. DOI: https://doi.org/10.1088/1742-6596/1013/1/012046

Misriani, E. N., Suhendar, S., & Ratnasari, J. (2023). Profil kompetensi berpikir sistem pada education for suistainable development menggunakan model problem based learning. *Jurnal Pendidikan Biologi, 12*(2), 211-218. DOI: https://doi.org/10.33627/oz.v2i2.1442.

Mubarik, A. L., Sutarqo, R. N. I., Sugiyarto, S., Masyithoh, G., & Nayasilana, I. N. (2022). Keanekaragaman jenis ikan dan habitatnya di perairan kawasan hutan dengan tujuan khusus (KHDTK) Gunung Bromo, Karanganyar, Jawa Tengah. *Zona Indonesia*, *31*(1), 18-31. DOI: https://doi.org/10.52508/zi.v31i1.4166

Mustari, A. H. (2020). *Manual identifikasi dan bio ekologi spesies kunci di Sulawesi*. Bogor: IPB Press.

National Geographic Indonesia. (2019). *Kepunahan biodiversitas tertinggi, Indonesia peringkat ke-6*. Retrieved from https://national-geographic.grid.id/read/131833161/kepunahan-biodiver-sitas-tertinggi-indonesia-peringkat-ke-6

Nurgiansah, T. H. (2022). Pendidikan Pancasila sebagai upaya membentuk karakter religius. *Jurnal Basicedu*, *6*(4), 7310–7316. DOI: https://doi.org/10.31004/basicedu.v6i4.3481

Nurhani, N., & Sifatu, W. O. (2018). Upacara peran dua kerajaan dalam mempertahankan Malabot Tumpe/Tumbe di Sulawesi Tengah. *Etnoreflika*, *7*(3), 158-166. DOI: https://doi.org/10.33772/etnoreflika.v7i3.547

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *International Journal of Surgery*, *88*, 105906. DOI: https://doi.org/10.1016/j.ijsu.2021.105906

Perwitasari, S., & Akbar, S. (2018). Pengembanga bahan ajar tematik berbasis kontekstual. *Jurnal Penelitian, dan Pengembangan*, *3*(3), 278–285. DOI: https://doi.org/10.17977/JPTPP.V3I3.10623

Purnawati, S., Suhendar, & Ratnasari, J. (2023). Development of e-module ESD context based on flipped classroom on self-awareness of junior high school students. *Bioeduscience, 7*(3), 261-270. DOI: https://doi.org/10.22236/jbes/12101

Purwianingsih, W., & Mardiyah, A. (2018). Analysis of pedagogical content knowledge (PCK) ability of science teachers in planning and reflect- ing on environmental pollution content. In *Journal of Physics: Conference Series*, (Vol. 1013, p. 012076) IOP Publishing. DOI: https://doi.org/10.1088/1742-6596/1013/1/012076

Purwianingsih, W., Novidsa, I., & Riandi, R. (2022). Program for integrating education for sustainable development (ESD) into prospective biology teachers' technological pedagogical content knowledge (TPACK). *Jurnal Pendidikan IPA Indonesia*, *11*(2), 219-228. DOI: https://doi.org/10.15294/jpii.v11i2.34772.

Rahim, F. M., Rahel, S. & Anindita, R. (2022). Peningkatan ekonomi warga Desa Pantai Mekar sebagai pengaruh ekowisata hutan mangrove di Kecamatan Muara Gembong, Bekasi. *Jurnal Penelitian dan karya Ilmiah Lembaga Penelitian Universitas Trisakti*, *7*(1), 37-44. DOI: https://doi.org/10.25105/pdk.v7i1.10393.

Ridho, S., Wardani, S., & Saptono, S. (2021). Development of local wisdom digital books to improve critical thinking skills through problem based learning. *Journal of Innovative Science Education*, *10*(1), 1-7. DOI: https://doi.org/10.15294/JISE.V9I1.37041.

Samatan, N., Wahyuni, W., Ariandi, P., & Robingah, R. (2023). Balêêle as a ritual to inherit Banggai cultural value. *International Journal of Advancende Multidiciplinary*, *2*(2), 516-534. DOI: https://doi.org/10.38035/ijam.v2i2.323.

Santrio, A., Mardiastuti, A., & Perwitasari-Farajallah, D. (2022, March). The characteristics of maleo bird (Macrocephalon maleo) eggs in the wildlife conservation area, North Buton, Indonesia. In *International Conference on Improving Tropical Animal Production for Food Security (ITAPS 2021),* (pp. 477-482). Atlantis Press. DOI: https://doi.org/10.2991/absr.k.220309.092.

Saragih, L., Riandi, R., & Solihat, R. (2021, March). The implementation of ESD into biology learning to equip students with ESD competencies of systemic thinking and problem-solving. In *Journal of Physics: Conference Series* (Vol. 1806, No. 1, p. 012158). IOP Publishing. DOI: https://doi.org/10.1088/1742-6596/1806/1/012158.

Setiawan, A. (2022). Keragaman hayati Indonesia: Masalah dan upaya konservasinya. *Indonesian Journal of Conservation*, *11*(1), 13-21. DOI: https://doi.org/10.15294/ijc.v11i1.34532.

Subuh, R. D., & Mulae, A. O. (2029). Strategi pengembangan kampung wisata berbasis masyarakat kepulauan di Pulau Hiri. *Jurnal Penelitian Humano*, *10*(2), 417–425. DOI: https://doi.org/10.33387/humano.v10i2.1448

Suyatno, S. (2016). Revitalisasi kearifan lokal sebagai identitas bangsa di tengah perubahan nilai sosiokultural. *METASASTRA: Jurnal Penelitian*

Sastra, *4*(1), 82-89. DOI: http://dx.doi.org/10.26610/metasastra.2011.v4i1.82-89.

Szombathy, Z. (2021). A trust from the ancestors: Islamic ethics and local tradition in a syncretistic ritual in East-Central Sulawesi. *Die Welt des Islams*, *61*(4), 448-474. DOI: http://dx.doi.org/10.1163/15700607-61020004

Rieckmann, M. (2017). *Education for sustainable development goals: Learning objectives*. Paris: UNESCO publishing.

Wantogia, M., Bempah, I., & Hamidun, M. S. (2024). Studi literatur tentang karakteristik spesies endemik Sulawesi burung maleo (*Macrocepalon Maleo*). *Jurnal Intelek dan cendekiawan Nusantara*, *1*(1), 445-454. DOI: https://doi.org/10.29408/edc.v18i1.12518.

Wibowo, A. E. A., Nurhadi, M., & Rezky, Y. (2015). Penentuan kesamaan reservoar sistem panas bumi Kadidia Dan Kadidia Selatan Kabupaten Sigi, Provinsi Sulawesi Tengah berdasarkan metoda geokimia. *Bulletin Sumber Daya Geologi*, *10*(2), 111–127. DOI: https://doi.org/10.47599/bsdg.v10i2.142

Yasir, M., & Hartiningsih, T. (2023, July). Studi Etnosains Keris Madura dalam Pembelajaran IPA untuk Mengembangkan Karakter Konservasi Cagar Budaya. In *Proceeding Seminar Nasional IPA*, (pp. 1-15). Retrieved from https://proceeding.unnes.ac.id/snipa/article/view/2274

Yusuf, D., Baderan, B. D. K., & Hamidun, M. S. (2024). Analisis bibliometrik penelitian burung maleo. *Jurnal Bionatural*, *11*(1), 71-79. DOI: https://doi.org/10.30605/biogenerasi.v9i1.3506.