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A Needs Analysis Study for Designing Borneo-Ecosystem Chatbot at Islamic Elementary School in Pontianak City

Roikhatul Janah[1*], Vidya Setyanigrum[2], Ghafriyadi[3], Farninda Aditya[4]
IAIN Pontianak, Indonesia[1-3], UNIMAS, Malaysia[4]
**Corresponding author : roikhatuljanah@iainptk.ac.id*

Abstract

This study aims to develop a conceptual design for a Borneo Ecosystem Chatbot called "Rimba" as an independent learning medium for Madrasah Ibtidaiyah (MI) students in Pontianak City. This study is a needs analysis study through the define and design stages in the Four-D development model. The results of the analysis can be used as a basis for developing independent teaching material for ecosystem material in Islamic elementary schools in the form of chatbots. The results of the analysis showed that students need digital media that is adaptive, enjoyable, and easily accessible. The Design stage produced an interactive chatbot design that integrates Borneo ecosystem content, Islamic values, and independent learning features with automatic feedback support. The "Rimba" chatbot is expected to increase students' independence, motivation, and understanding of ecosystem concepts in a contextual and religious manner.

Keywords: *: Chatbot; Borneo Ecosystem; Independent Learning; Madrasah Ibtidaiyah.*

INTRODUCTION

Madrasah Ibtidaiyah (MI) is a basic educational institution that has the distinctive feature of internalizing Islamic values in its learning activities. The role of MI in Indonesia includes integrating religious values through basic education, character development, and overcoming educational inequality (Apriyani et al., 2025; Munawir et al., 2024; Napi'ah & Ayuningsih, 2025; Septya et al., 2024). The need for religious education in primary education is increasingly recognized as important for promoting moral development, cultural understanding (Nunes & Tomasi, 2025), and social cohesion among young students (Maksum et al., 2025). This component of education not only instills knowledge about various religions but also internalizes values such as tolerance (Chorna, 2023), empathy, and respect for diversity.

MI faces significant challenges in the 21st century. According to (Juárez Ramírez, 2020; Nurkholes & Pramuja, 2024) there must be a shift towards more relevant and engaging learning methodologies. The integration of contemporary skills into the religious-based curriculum is essential to encourage moral development and prepare students for the demands of modern society (Fitriah et al., 2025; Sianturi & Romika, 2024). As technology develops in the 21st century, MI must also keep up with these technological developments in implementing its learning.

Chatbots are one technology that can be utilized in learning. Chatbots function as a digital learning resource that can respond to questions from users in real-time, thereby enhancing the learning process without the need for direct interaction with humans. According to Ayuningtyas (2024), chatbots provide full access to the information presented at any time, allowing students to engage with educational content anytime and anywhere. Chatbots can also meet diverse learning needs by offering a variety of content and questions that can be tailored to user inquiries, thereby supporting independent learning experiences for students.

The integration of technology in MI is very important to encourage students independent learning. This approach not only increases educational productivity but also aligns with contemporary curriculum requirements that must adapt to the times. According to Prasetiyo and Andi Prastowo (2022), technology facilitates students' ability to complete tasks independently, as evidenced by research showing that students can submit structured assignments without adult assistance, encouraging autonomy. Through this technology, users, including students, are able to learn anytime and anywhere. According to (Rizkia Muhammad & Saepulloh, 2025), the use of digital media can be flexible to meet the needs of students independently. In addition to helping students in independent learning, according to (Qamariyah, 2024) technology can also improve teachers' pedagogical skills and encourage their creativity in designing lesson plans so that they can apply innovative learning methods. Thus, the use of technology such as chatbots can make learning more interesting and help students understand complex concepts more effectively (Firdaus, 2023).

Chatbots are increasingly relevant for independent learning due to their ability to provide personalized, interactive, and accessible educational support. These AI-based tools facilitate a learning environment, encouraging exploration and independent learning, in line with modern educational goals. According to (Lan & Giam, 2024), chatbots can tailor to the needs of each learner, increase learner engagement and

motivation. Chatbots provide 24/7 access to available information, allowing learners to explore learning topics at their own pace and convenience. In line with Lan's statement, (Valencia-Valencia, 2022) argues that chatbots can support the development of student skills, such as time management and planning, enabling them to organize their own independent learning. Chatbots can also develop students' problem-solving abilities by offering feedback and encouraging independence

The effectiveness of chatbots in learning has been supported by various studies, showing moderate to high impacts on educational outcomes in various contexts. Meta-analyses reveal that chatbots can enhance learning (Alemdag, 2025; Deng & Yu, 2023), particularly in language acquisition (Lyu et al., 2025; Wang et al., 2025) and continuing education, by providing immediate feedback and facilitating interaction (PENG et al., 2023).

In the context of natural sciences at the elementary education level, according to (CHEN, 2023), chatbot-assisted game-based learning has been proven to significantly improve science learning outcomes. Similarly, research results from (Mahya & Setiawan, 2024) show that the carabisatulus chatbot developed for environmental science demonstrates significant effectiveness for student learning. In addition to influencing learning outcomes, the use of chatbots in learning can also effectively improve science achievement and interest among students (Lee et al., 2023).

Ecosystem material in natural science education is one of the subjects that must be studied by fifth-grade students or phase C students in madrasah ibtidaiyah. In the current curriculum, ecosystem material is presented in general content that is not specific to the Borneo ecosystem. Incorporating Borneo ecosystem material into ecosystem material for basic education is very important to foster environmental awareness and understanding among children. Integrating the topics of biodiversity and local conservation can increase student engagement and understanding of ecological principles. According to (Abdurrahman et al., 2022), educating students about the Borneo ecosystem can instil a sense of responsibility for environmental conservation. With the Borneo ecosystem material, students learn science that is very close to their lives, making learning contextual and therefore more relevant and meaningful to students (Slamet et al., 2024).

Although various studies have shown that chatbots are effective in improving learning outcomes, learning independence, and student engagement in various

educational contexts, such as research by (Alemdag, 2025; Selvina et al., 2023; Yulianti et al., 2025), there are still several research gaps that have yet to be filled. For example, specific studies on developing chatbots tailored to the characteristics of madrasah ibtidaiyah students in line with curriculum needs have not yet been conducted. Researchers have not found any studies on the development of chatbots that specifically integrate local content such as the Borneo ecosystem, which is highly relevant to MI students in Pontianak. Previous studies have mostly focused on generic science content, so that aspects of local contextualization and environmental education based on local wisdom have not yet been optimized in technology-based learning media.

Based on these findings and their urgency, the development of an ecosystem chatbot as a self-learning medium in State Islamic Elementary Schools (MIN) throughout Pontianak City is highly relevant and should be pursued through a systematic approach, namely the Four-D Model (Define, Design, Develop, and Disseminate). However, the initial stages of Define and Design are crucial foundations that need to be examined in depth, so the development of chatbots is truly in line with the characteristics of MI students, the needs of the Islamic-based curriculum, and the local educational context in Pontianak.

METHODS

This research was a type of research developed using the Four-D development model. As suggested by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel, Four-D development model consists of four stages, namely Define, Design, Develop, and Disseminate. These four stages are then adapted into definition, design, development, and dissemination (Abadi, 2022). Based on this research focus, this study only focused on the define and design stages. The define stage was carried out to defining the development requirements, often referred as requirements analysis stage. The requirements analysis or need analysis was conducted through a literature study.

According to Thiagarajan in (Abadi, 2022), five analysis activities were carried out in the define stage/ requirement stage/ need analysis stage, including: front analysis (researchers conduct an initial diagnosis to improve learning efficiency and effectiveness), learner analysis (researchers analyze learner characteristics, including abilities, learning motivation, prior knowledge, and learning styles), task analysis (researchers analyze the main tasks that students must master to achieve minimum competency), concept analysis (analyzing the concepts taught, compiling the steps to be

taken rationally), and instructional objectives (writing learning objectives with operational verbs, expected changes in student behavior after learning).

The design stage aimed to design the learning tools. There were four steps in this stage, including: compiling test standards, selecting media that are appropriate for the characteristics of the material and learning objectives, selecting the format of the teaching module to be developed, and creating a preliminary design in accordance with the selected format.

RESULTS AND DISCUSSION

Results

In the Define stage, the researchers conducted preliminary research by interviewing fifth-grade teachers at MIN schools in Pontianak City. The interviews were divided into four topics, including: initial-final analysis, student analysis, task analysis, and concept analysis. In the initial-final analysis, the researcher conducted interviews using six open-ended questions about learning objectives, learning resources, learning media, evaluation, and learning technology commonly used in IPAS learning of ecosystem material.

In the student analysis, the researcher conducted interviews using five open-ended questions about the characteristics, learning styles, and abilities of students in using technology for learning, the difficulties commonly experienced by students in learning about ecosystems, and the main requirements for understanding ecosystems. In the task analysis, the researcher conducted interviews using three open-ended questions about how teachers determine tasks, the tasks that are usually given to students for ecosystem material, and the difficulties or obstacles related to the tasks created by teachers.

In the concept analysis, the researcher conducted interviews using six open-ended questions about the sub-material taught on the topic of ecosystems, the concepts taught on the topic of ecosystems, the contextualization of ecosystem material with the Borneo ecosystem, the methods or strategies used to teach ecosystems, the obstacles encountered in learning about ecosystems, and misconceptions about ecosystem material. Based on the open-ended questions in the define stage above, the researcher concluded that the requirements n for the development of the Borneo Ecosystem Chatbot can be drawn as follows:

Table 1. Results of needs analysis

No	Question	Needs Analysis
1	Initial analysis: learning objectives, learning resources, learning media, evaluation, and learning technologies commonly used in IPAS learning of ecosystem material.	1. The learning objectives in the chatbot should consist of: (a) To analyze the relationships between living things in an ecosystem in the form of food webs. (b) To describe the process of transformation between living things in an ecosystem. (c) To describe how energy transformation in an ecosystem plays an important role in maintaining the balance of nature. 2. The reference material in the chatbot should refer to: "Natural and Social Sciences for fifth Grade Elementary School". 3. The chatbot should be developed by adding videos referring to contextual media. The chatbot should be tested for validity and its effect on student learning outcomes. 4. The chatbot should be developed by adding videos referring to contextual media. 5. The chatbot should be developed by adding videos referring to contextual media (images and videos), including Malay language, and features quiz confirmations through enrichment.
2	Analysis students: characteristics, learning styles, students' ability to use technology for learning, difficulties commonly experienced by students in learning about ecosystems, and the main requirements for understanding ecosystems.	1. The chatbot should take into account the diverse characteristics of students and be able to activate student activities. 2. The chatbot should accommodate the auditory, kinesthetic, and visual learning styles of students. 3. The chatbot should be able to be operated by students on their own cell phones. 4. The chatbot should contain contextual material about ecosystems (Borneo ecosystems). 5. The chatbot should contain contextual material.
3.	Task how analysis: teachers determine tasks, tasks that are usually given to students for ecosystem material, difficulties and or obstacles related to tasks created by	1. Quizzes within the chatbot must be developed in accordance with learning objectives. 2. The quiz in the chatbot should take the form of multiple-choice questions and provides enrichment.

	teachers.	
4.	Concept analysis: sub-topics taught in the ecosystem topic, concepts taught in the ecosystem topic, contextualization of ecosystem material with the Borneo ecosystem, methods or strategies used to teach ecosystems, obstacles encountered in learning about ecosystems, misconceptions in ecosystem material.	1. The subtopics discussed in the chatbot should include: (a) Biodiversity in Indonesia (b) Diversity of flora and fauna in Indonesia 2. Concepts discussed in the chatbot should be: biodiversity and various types of flora and fauna found in West Kalimantan. 3. The chatbot should integrate the Borneo ecosystem. 4. The presentation of material should be integrated with reading materials and educational videos. 5. The material on the chatbot should be in line with the Borneo ecosystem. 6. The chatbot on ecosystem harmony and food chains and food webs should be packaged in a more contextual form.

The results of the needs analysis in the define stage, based on interviews conducted by the researcher, guided the design stage. In the design phase, the researcher designed a conceptual chatbot design, including interaction features, learning content, and a dialogue structure that supported independent and contextual learning. The conceptual design of the ecosystem chatbot in this study is as follows:

Table 2. Chatbot Design Concept

Component	Definition in the "Rimba" context	Notes/Relationships Four-D Model
Learners (Users)	MI students in Pontianak City. Characteristics: ages 7-12 years old, basic digital skills, learning context of religion + environmental science.	Define Stage: analysis of needs and characteristics.
Teachers & Facilitators (Stakeholders)	MI teachers, school environmental advisors, and parents, act as facilitators or monitors of chatbot usage progress.	Define: identification of stakeholders and their needs.
Learning Content	Theme: "Borneo Ecosystem". Sub themes: for example, Kalimantan's tropical rainforest, endemic flora/fauna, religious values in preserving nature, conservation concepts.	Design: content structure, learning map.
Chatbot Interaction	Interactive with Rimba: Q&A, quizzes, simulations, stories, progress monitoring, learning path recommendations.	Design: dialogue scenarios, UI/UX, flow.

Technology & Platform	Chatbot Platform (web or mobile app) connected to a server, content database, analytics, gamification, modules.	Design: Technical architecture, System Integration.
Self-directed Learning	Students should be able to access anytime, anywhere, exploratory, personalized pace and content, automatic feedback support.	Define + Design: directed learning needs, personalization features.

The conceptual framework for Rimba chatbot has placed MIN students in Pontianak City as the main users in a technology based independent learning ecosystem. Through the Define stage, user characteristics, learning needs, and school environment elements have been identified. The Design stage then designed an interactive chatbot that has integrated 'Borneo Ecosystem' content and religious values, as well as a technology platform supporting personalization and monitoring. Teachers and parents function as stakeholders in the chatbot, while the technology, content, and chatbot interaction form an adaptive independent learning system. The expected outcome is an increase in students' independence, motivation, and understanding of ecosystem material, which then should further be developed in the Develop and Disseminate stages. Below is the chatbot design:

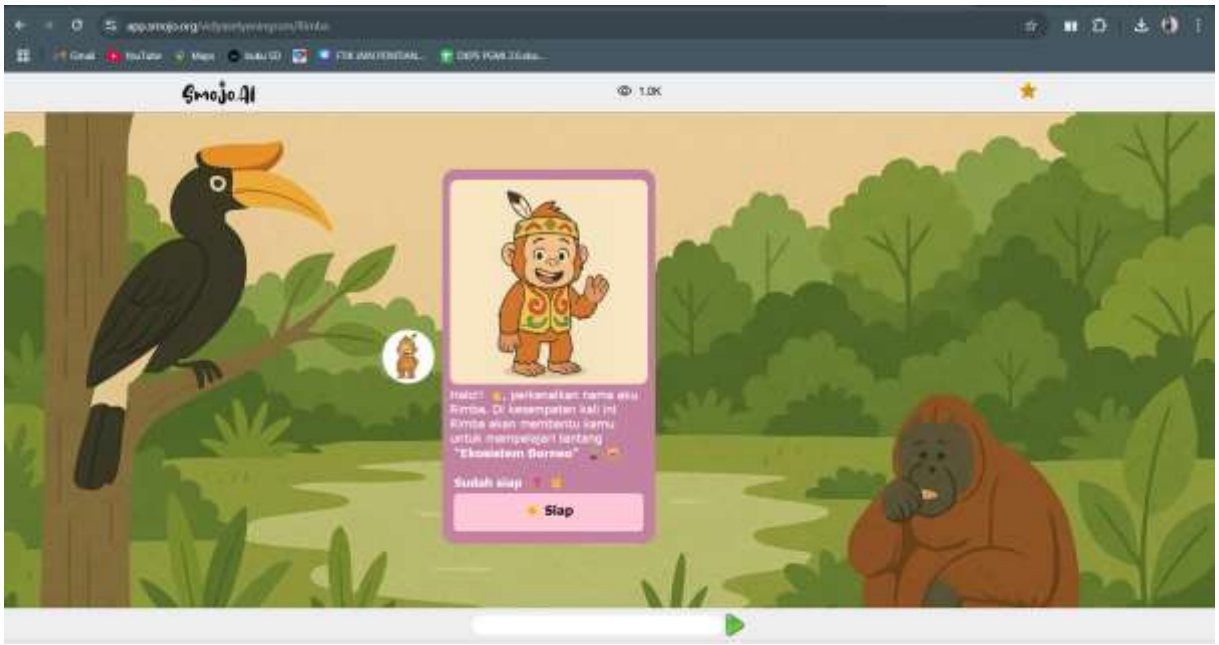


Figure 1. Initial Section of the “Rimba” Chatbot

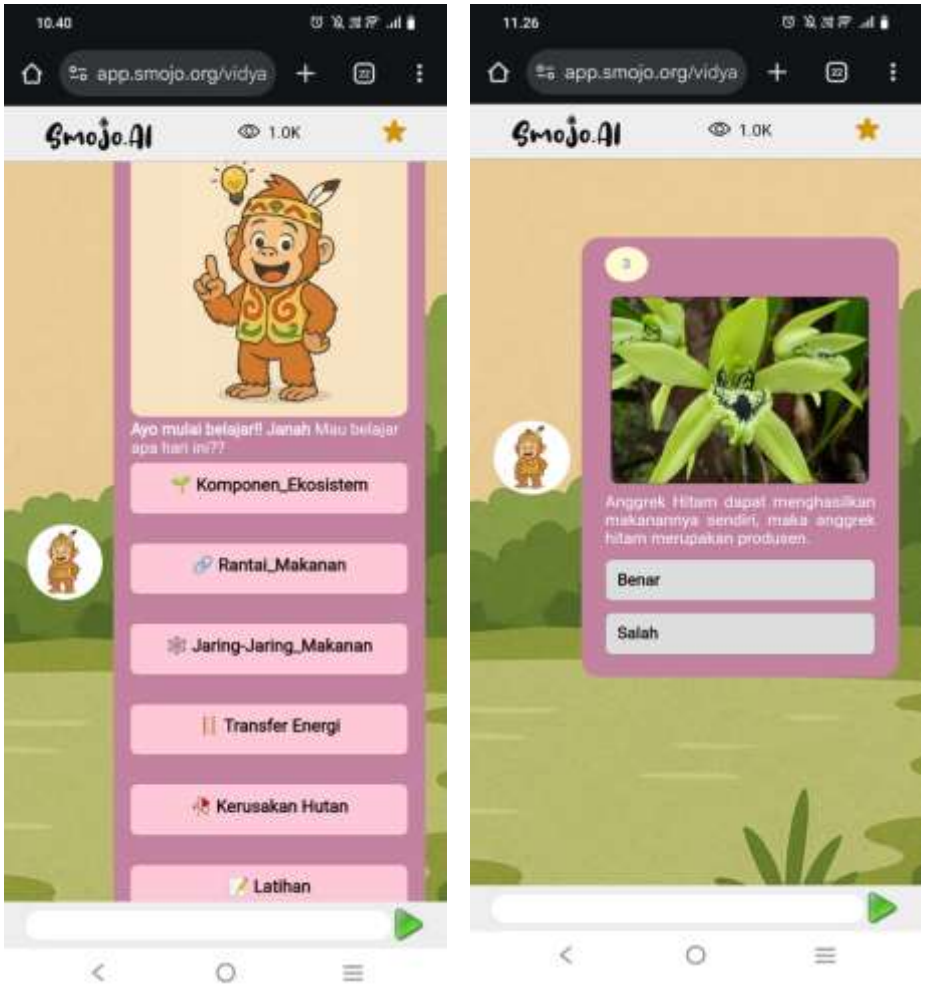


Figure 2. Materials and Quiz Section of the "Rimba" Chatbot

Discussion

The define stage in this study produced an in-depth analysis of the needs of teachers and students at MIN in Pontianak City. The results of the analysis indicated the need for contextual, interactive, and adaptive learning media tailored to the characteristics of MIN students, particularly for understanding the concept of ecosystems. These findings are in line with the first stage of the Four-D model by Thiagarajan, Semmel & Semmel, as cited by (Simatupang et al., 2024), namely the define stage, emphasizing the analysis of user needs and the learning context.

The researchers found that teachers still used conventional learning resources such as textbooks, with limited technology integration and a lack of locally-based media. This indicates a learning gap between 21st-century learning needs and learning practices that are still dominated by lectures and memorization. According to TPACK

theory, the success of technology-based learning is determined by the integration of teachers' pedagogical, content, and technological knowledge. Therefore, the development of the Rimba Chatbot is relevant because it facilitates teachers and students in optimizing TPACK components through digital interactions that present local-based scientific content (Borneo Ecosystem) in an Islamic context (Adipat, 2023).

The results of a needs analysis conducted through interviews with fifth-grade MIN teachers throughout Pontianak City showed that the development of the Borneo Ecosystem Chatbot “Rimba” is based on the needs of students and teachers in learning. Based on four aspects of analysis; front-end, students, tasks, and concepts, it was found that IPAS (Natural and Social Sciences) learning on ecosystem material was still conventional, limited to textbooks, and did not yet make optimal use of interactive technology. These findings are in line with research by (Sudarsih, 2025), which shows that science learning at the elementary level may still be largely teacher-centered, with minimal use of digital technology. In this context, the use of interactive chatbots is a form of technology-based learning innovation that is adaptive to the local context and the needs of the 21st century.

The conceptual design of the “Rimba” chatbot integrates thematic learning content on the “Borneo Ecosystem,” emphasizing the contextualization of material with the local environment of West Kalimantan and Islamic values in preserving nature. This integration demonstrates a contextual-spiritual approach, which is rarely raised in the development of AI-based learning media for Islamic elementary education. The development of this chatbot refers to the Four-D model (Define, Design, Develop, Disseminate) proposed by Thiagarajan, Semmel, & Semmel (Abadi, 2022). In the Define stage, a needs analysis was conducted to identify problems and learning potential; while in the Design stage, a conceptual solution was designed in the form of a chatbot system with interactive and contextual features.

In the context of learning theory, the design of the “Rimba” chatbot reflects the principles of Constructivism by Piaget (Idham, 2024) and Contextual Teaching and Learning (CTL) by Johnson (Reddy & Revathy, 2024), in which students construct knowledge through direct experience and connection with the real world. Chatbots that contain simulations, quizzes, and interactive stories facilitate active learning and meaningful learning, as suggested by Ausubel (da Silva, 2020).

Furthermore, the approach used is also in line with the Multimodal Learning

theory (Mayer, 2009), which emphasizes the importance of presenting information in various forms—text, audio, and visual—to accommodate different learning styles (auditory, visual, kinesthetic). This is relevant to the analysis of students at the Define stage, which requires interactive learning media that can accommodate the diversity of learning styles of madrasah students.

In the context of Islamic elementary education, natural and social science learning aims not only to build science literacy but also to integrate Islamic values and environmental awareness. The "Rimba" chatbot, which raises the theme of "Borneo's Ecosystem" with religious nuances (for example, narratives about the mandate of humans as khalifah fil-ardh), supports the paradigm of the integration of science and religion as stated by Al -Attas in (Muslih et al., 2022) and reinforced by (Asnawi, 2012) on the importance of contextual Islamic education based on environmental values. Thus, this chatbot innovation not only serves as a digital learning medium but also as a means of internalizing spiritual values through technology-based interactions. This indicates a shift from merely a digital learning tool to a value-based intelligent learning assistant, which is still rarely found at the madrasah ibtidaiyah level.

Previous studies such as (Selvina et al., 2023), (Yulianti et al., 2025), and (Kasmayanti et al., 2023) developed chatbots for science learning in elementary schools with a focus on the ability to answer questions and practice problems. However, none have linked chatbots to the local ecosystem context (Borneo) and the integration of religious values at the Madrasah Ibtidaiyah level. The finding showed that teachers want contextual and interactive media reflects the gap between 21st-century learning needs and the availability of media in madrasahs. The "Rimba" chatbot addresses this gap by adopting student-friendly technology that can be accessed via mobile devices.

However, the analysis also showed that most teachers still had limited mastery of learning technology. This poses an implementation challenge, as the successful use of chatbots depends on the readiness of teachers as facilitators (Mishra, P. & Koehler, 2006). Therefore, mentoring and training programs are needed so that madrasah teachers can effectively integrate chatbots into their teaching practices. Theoretically, this study contributes to the development of an AI-based contextual learning model oriented towards the integration of Islamic values. This study reinforces the argument that chatbot-based learning can be an effective means of building self-regulated learning and intrinsic motivation among madrasah students, in line with the thoughts of Garrison in (Mayasari et al., 2019) and Zimmerman. Practically, the "Rimba" chatbot can be an

innovative model of local-based IPAS learning media that can be replicated in other madrasahs in Kalimantan or other areas with similar ecological contexts.

Overall, the results of this study indicate that the development of the “Rimba” chatbot based on the Borneo Ecosystem is a form of learning innovation that represents the synergy between technology, locality, and spirituality in Islamic elementary education. This approach contributes new insights to the practice of education for sustainability in madrasah ibtidaiyah, while strengthening the direction of developing humanistic and character-based artificial intelligence-based learning media.

CONCLUSION

The development of the Borneo Ecosystem Chatbot, named "Rimba," is a strategic step in bringing self-directed learning innovation to Madrasah Ibtidaiyah (MI), particularly in the context of Natural and Social Sciences (IPAS) ecosystem material. The results of the analysis in the Define stage showed that MI students in Pontianak City need contextual, interactive, and easily accessible learning media that can integrate local Borneo content, including the provision of video-based materials, interactive quizzes, and the integration of environmental values relevant to students' daily lives. Therefore, the design of the Borneo ecosystem chatbot focuses on an adaptive, enjoyable, and contextual learning approach that takes into account the diverse characteristics of MI students.

Through the Design stage, the Borneo ecosystem chatbot was conceptualized as a digital learning system that places students at the center of learning activities, supported by artificial intelligence-based interactions, multimodal content, and automatic feedback features. Teachers and parents act as facilitators and supervisors of student development, while technology becomes the main means of creating an independent and flexible learning experience. Thus, the Borneo ecosystem chatbot is not only an innovation in learning technology, but also an educational solution that is relevant in strengthening ecological literacy and the independence of MI students in the digital era. We would like to express our gratitude to LP2M IAIN Pontianak for providing research funding from the 2025 DIPA Budget.

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