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E-Modin Local Wisdom to Improve Learning Outcomes and Science Literacy

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Abstract

The role of teachers in utilizing learning media in schools reflects the needs and abilities in terms of development, adaptation of technological developments, and creating learning motivation for students to achieve learning goals optimally. In this case, school management has a role that can support the utilization of learning media to be applied by teachers in schools. The purpose of this study was to evaluate the role of teachers in utilizing learning media in SD Negeri Tukang, using the Formative-Sumative Evaluation Model which is associated with the stages of school management. The process of school management is the planning stage, the organizing stage, the implementation stage, and the supervision stage which involves evaluation. The methodology of this study is descriptive qualitative.TData collection techniques using questionnaires, interviews, and observations. Data analysis techniques using data reduction, data presentation, and drawing conclusions. The results of this study indicate that the role of teachers in utilizing learning media at SD Negeri Tukang has been implemented. However, most teachers do not maximize the use of media provided by the school, and lack the ability to utilize digital-based learning media that follow the development of the times.

Introduction

According to Sekuloska (2014) and Sumual et al. (2024), education is a key pillar in developing superior and competitive human resources. Within it, the learning process is a central activity, reflecting the interaction between teachers as facilitators and students as subjects of learning. Through this process, knowledge transfer, skills formation, and values instillation occur, supporting students' intellectual development (Pea, 1987; Baartman & De, 2011; Felder & Brent, 2004; Slavich & Zimbardo, 2012).

The role of teachers in the context of 21st-century learning is required to be more than simply a conveyor of information; teachers must be learning leaders capable of creating an active, creative, effective, and enjoyable learning environment, taking into account the individual characteristics and potential of students (Opdenakker, M. C., & Minnaert, 2011; Magen-Nagar & Steinberger, 2017; Kember et al., 2010).

Differences in learning abilities among students are a logical consequence of variations in internal factors such as intelligence, interests, motivation, and readiness to learn, as well as external factors such as the learning environment, curriculum, and teaching quality (Ramli et al., 2018; Tomlinson et al., 2003; Firman et al., 2020). Therefore, educational success depends heavily on the extent to which the learning process can adapt to the needs and backgrounds of students.

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In an effort to address post-pandemic educational challenges and the low literacy achievements of Indonesian students at the international level, the government launched the Independent Curriculum (Kurikulum Merdeka) in February 2022. This curriculum was designed as a solution to learning loss and to improve the quality of competency-based and differentiated education.

This was based on the results of the 2022 PISA (Paris-Illegible Student Assessment) which showed that Indonesian students' scientific literacy scores were far below the OECD average, at 383 compared to the OECD average of 485, with approximately 70% of students not yet reaching a basic level of proficiency.

Scientific literacy is defined as the ability to understand, evaluate, and apply scientific concepts and processes in real-life contexts (Costa et al., 2021; Sadler & Zeidler, 2009; Sunandar et al., 2022). The low level of scientific literacy of students is caused by various factors, such as a teacher-centered learning approach, lack of learning resources, limited laboratory facilities, and low motivation and cognitive abilities of students (Voogt et al., 2009; Folashade, 2023).

In developing this research, the implementation of inquiry-based learning models, such as guided inquiry, is an effective strategy proven to improve scientific literacy and student learning outcomes. This model enables students to actively engage in learning, develop critical thinking skills, and connect scientific concepts to real-life situations (Tari & Rosana, 2019; Verawati & Sarjan, 2023; Kek & Huijser, 2011).

Inquiry learning also aligns with the spirit of the Independent Curriculum, which emphasizes contextual, holistic learning, and is oriented toward student character development (Zainuddin et al., 2025; Kotsis, 2024). However, in several 3T (frontier, outermost, and disadvantaged) regions, science learning practices still face serious obstacles. A case study at SMPN 1 Long Pahangai, East Kalimantan, shows that conventional learning approaches remain dominant, the use of teaching materials is limited to textbooks, and there is minimal integration of technology and contextual approaches based on local culture.

Observations and interviews indicate that most students experience difficulty understanding the material due to language barriers, limited reading materials, and low interest and ability in reading. The low science learning outcomes among students, as evidenced by average scores below the minimum standard (KKTP), also reflect the need for innovative and relevant learning interventions. The language barrier between teachers from outside the region and students who speak the local language (Bahasa Bahau) is a barrier to understanding the material.

Given the importance of local context in the learning process, a local wisdom-based approach is a potential solution. Local wisdom encompasses cultural values, customs, and traditional knowledge of a community. When integrated into learning, it can create contextual, meaningful learning experiences and strengthen students' cultural identity (Haluti, 2024; Miranti et al., 2024 Fahrieyah, 2024). Integrative programs such as SHILL (Science and Heritage Language Integrated Learning) have demonstrated positive impacts on students' learning interest and scientific literacy (Schiefer et al., 2024).

Therefore, to address these challenges, the development of inquiry-based e-modules and local wisdom was designed to help science learning become more easily understood by students. E-modules are digital learning media capable of presenting material systematically, interactively, and flexibly accessible to students. Various studies have shown that e-modules based on local wisdom and inquiry approaches are effective in improving critical thinking skills, scientific literacy, and student learning outcomes (Marlina et al., 2025; Annam et al., 2024).

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By combining a guided inquiry learning approach and local wisdom in the form of locally-based e-modin, it is hoped that the challenges of low student learning outcomes and science literacy, particularly in areas with limited resources and cultural diversity, can be addressed. This learning innovation is a concrete manifestation of the implementation of the Independent Curriculum, which is contextual and adaptive to the needs and characteristics of students in various regions of Indonesia.

Methods

This research is a type of research and development (R&D) that aims to produce an inquiry-based e-module product with the integration of local Dayak Bahau wisdom in science learning. The development model used is 4D (Define, Design, Develop, Disseminate) developed by Thiagarajan et al. (1974). The research subjects consisted of three main groups: (1) expert testing, involving two material experts, two media experts, and two local Dayak Bahau culture experts; (2) development trial, involving six grade VII students with high, medium, and low academic abilities and one science teacher; and (3) product trial, conducted on 30 grade VII students of SMPN 1 Long Pahangai as end users of the e-module. Data collection methods were conducted through two main techniques: questionnaires and tests. The questionnaire instrument was used to measure the level of validity and practicality, both from experts, teachers, and students. The questionnaire was constructed using a five-point Likert scale. Meanwhile, the test technique was used to evaluate scientific literacy skills and student learning outcomes through pre-tests and post-tests. The literacy test was structured in the form of essay questions adapted to PISA (2019) indicators, while learning outcomes were measured through multiple-choice questions referring to the revised Bloom's taxonomy. The data analysis techniques used consisted of qualitative and quantitative descriptive analysis. Qualitative analysis was conducted on non-numerical data in the form of suggestions, responses, and comments from experts, teachers, and students, which were then interpreted as material for product evaluation and revision. Quantitative analysis was conducted through calculating the percentage of questionnaire and test scores, validity analysis using Gregory's formula, and instrument reliability using Cronbach's Alpha. The effectiveness of local wisdom e-modin was analyzed using a one group pretest-posttest design, and the improvement in learning outcomes and science literacy was measured using N-Gain analysis in the moderate category and the achievement of KKTP of at least 70 for learning completion.

Results and Discussion

The Dayak Bahau local wisdom-based e-Modin was developed based on Thiagarajan's 4D model (Define, Design, Develop, Disseminate), emphasizing the integration of science content and local culture. The module's validity, practicality, and effectiveness were thoroughly tested using various instruments, involving experts and direct users (teachers and students). During the Define stage, several obstacles were identified in the science learning process, such as the dominance of lecture methods, a lack of teaching materials, and students' low reading skills. Furthermore, language barriers predisposed students to use their local languages for communication. To address these issues, the module was developed using a guided inquiry approach that requires students to actively observe, ask questions, and draw conclusions (Liana et al., 2022; Winkelmann et al., 2015) and utilizes local wisdom to engage students in science learning.

During the Design stage, the e-module was developed digitally with the help of applications such as Canva, Flip PDF, and 2APK Builder. This module covers the classification of living things, ecology, and the solar system. These three sections are packaged in an inquiry-based learning model, with components of orientation, problem formulation, hypothesis formulation,

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data collection, hypothesis testing, and conclusions. It also includes quizzes, reflections, and visual and video content based on Bahau culture, making learning more contextual and engaging (Robbins, 2006). The Development phase involves validity testing of three aspects: material, media, and local wisdom: individual testing; small group testing; and field testing. The assessment results were very good, as summarized in Table 1 below:

Table 1. E-Module Validation Results

Validation Aspect	Gregory Value	Description
Material Validation	1.00	Excellent
Media Validation	1.00	Excellent
Local Wisdom Validation	1.00	Excellent

Validation of the material was carried out by experts from the field of science, the media was validated by learning media experts, while the local wisdom aspect was reviewed by traditional figures and Dayak Bahau cultural activists. The validation results obtained from material experts in Gregory's calculations obtained a validation value of 1.00 meaning that the validity is very good, so that from the material side of local wisdom e-modin can be continued to the usage test, only need to make some revisions in the form of correcting incorrect printing and improving the concept map. The validation results of media experts show a Gregory value of 1.00 which means the media is very good to use, only need to make light revisions in the form of improving the image layout and inclusion of image sources, as well as the placement of the glossary provided at the end of each chapter.

The purpose of improving the images is in accordance with the opinion of Wang et al. (2023) and Trier (2008), that visualization is not only a complement, but a form of communication in itself that can enrich meaning and convey information more directly, intuitively, and comprehensively, especially in complex learning contexts so that it can help build students' cognitive schemes to understand objects or concepts and strengthen their memory so that images have a significant contribution in supporting the quality of learning because it helps concretize abstract concepts, increase information retention, and enrich students' learning experiences as a whole. The results of the validation of cultural experts on the local wisdom of the Bahau Dayak integrated into the local wisdom e-modin obtained a Gregory value of 1.0, which means that the Bahau local wisdom presented is in the very good category, with revisions to improve the use of words and typos corrected according to expert suggestions.

This review accuracy indicator is in accordance with the findings obtained from Fitrianto & Farisi (2025); Verawati & Wahyudi, (2024) and Setiawan et al. (2017) through local wisdom, science learning that has been validated will be able to provide real and contextual learning experiences, as well as space for students to explore their local culture. The validation results of the Dayak Bahau local wisdom-based e-modin, assessed by material experts, media experts, and cultural experts, showed valid results and were suitable for further testing. Individual testing was conducted on three seventh-grade students from SMPN 2 Long Pahangai. The results showed achievement percentages of 96.17%, 98.30%, and 99.15%, respectively. This indicates that the local wisdom-based e-modin has excellent qualities in terms of attractiveness, content presentation, user-friendliness, and usefulness.

Table 2. Individual Test Results

Indicator	R1	R2	R3
Attractiveness	4.36	4.36	4.36
Content/Material Presentation	4.69	4.64	4.83
Ease of Use	4.50	5.00	4.00

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Usefulness	4.29	4.86	4.86
Total Score	226.00	231.00	233.00
Total Score of All Aspects	96.17	98.30	99.15

A small group practicality test of 7th-grade students at SMPN 2 Long Pahangai yielded a Gregory calculation score of 1.00 and an overall aspect assessment score of 82.98%-92.77%. This indicates that the Bahau local wisdom-based inquiry e-module has excellent practicality and is therefore suitable for use in product trials.

Table 3. Practicality Test with Students

Indicator	R1	R2	R3	R4	R5	R6
Attractiveness	5.0	4.5	5.0	4.9	4.6	4.5
Content Presentation	4.6	4.2	4.9	4.4	4.6	4.7
User-Friendliness	4.3	4.5	4.3	4.0	5.0	4.5
Usefulness	5.0	4.3	4.6	4.9	4.7	5.0
Gregory Test Tabulation Total Score	47		47		47	
Gregory Validity Coefficient (GVC)	1		1		1	
Total Score	211	195	218	202	204	209
Total Score of All Aspects (%)	89,79	82,98	92,77	85,96	86,81	88,94

The field test was conducted on 30 7th grade students of SMPN 1 Long Pahangai, by providing local wisdom e-modin in learning, and students were then given an objective test of 20 questions to determine the level of learning outcomes obtained and 5 essay questions to determine the level of students' scientific literacy abilities. The results obtained from this field test obtained the following data:

Table 4. Results of E-Module Effectiveness (N-Gain Score)

Learning Aspect	Average Pre-test	Average Post-test	N-Gain Score	Category
Learning Outcome	50.39	71.83	0.43	Medium
Scientific Literacy	43.67	72.28	0.50	Medium

The learning outcome assessment obtained an n-gain score within the moderate criteria. The increase in the percentage of students with good scores demonstrates that learning with the inquiry e-module is effective in helping improve student learning outcomes. This is consistent with findings from Dini et al. (2023), that the guided inquiry e-module is able to improve student learning outcomes because it presents material interactively and allows students to explore concepts through inquiry.

Through the main support in the form of material content that is appropriate to the students' learning ability level and pays attention to the close relationship between Bahau local wisdom and students' lifestyle habits, this supports students' ability to understand the material presented. Nosofsky (1987) stated that effective learning occurs when there is a similarity between the stimulus (presented in the media) and the performance to be learned. A similar statement by Delıta et al. (2022) states that appropriate learning materials will facilitate student learning. In addition, the activities and learning objectives presented in the e-module make learning easier for students.

The development of an inquiry e-module based on Bahau local wisdom will help students retain their learning experiences longer. This is evident in the average student score across the entire

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material, which rose from 51.04 to 72.11. This data demonstrates improvements in student learning through the developed e-module. This improvement in learning outcomes also indicates that students are able to learn effectively and understand the content of the developed e-module.

The improvement in student learning outcomes is not only related to the supporting content but also to the presentation of features such as videos, images, summaries, brief information, and quizzes within the e-module. This can help students more easily understand the material and actively engage in the learning process. This aligns with findings by Sari et al. (2024) that the use of e-modules with the addition of learning videos and relevant images can enhance student engagement, enhance student learning experiences, and enhance comprehension, particularly in learning.

Through the design of e-modules that use a student-centered inquiry learning model, students are able to develop their thinking skills and seek answers to the questions posed, which indirectly stimulates students to think in solving a problem. This activity allows for a connection between problems faced in learning and students' thinking skills, so that students' cognitive abilities can be significantly improved. This is consistent with the findings of Bunterm et al. (2014), that the effect of guided inquiry on learning outcomes is greater than traditional teaching (transmissionist instruction).

The guided inquiry learning model is able to improve student learning outcomes compared to students who are taught using routine learning models such as lectures and discussions. Based on the data obtained, the n-gain for learning outcomes was 0.43 and scientific literacy was 0.50, indicating that all learning materials are in the moderate category ($0.3 < g > 0.7$). According to Liana & Indrowati (2022), an N-gain score in this category indicates that the use of inquiry-based e-modules is quite effective in improving student learning outcomes. Thus, the moderate category indicates room for further improvement, particularly in optimizing the use of e-modules in learning.

Table 5. Student Learning Outcomes

Material	**Percentage of Students in Good Presentation Category**	**Percentage of Students Achieving Mastery (Score ≥ 71)**
Classification of Living Things	60%	66.67%
Ecology and Biodiversity	70%	80%
Earth and the Solar System	70%	76.67%

The achievement of PAP learning outcomes shows that 60% of students have a good category in the material of classification of living things, 70% of students achieved a good PAP in the material of ecology and biodiversity, and 70% of students achieved a good PAP in the material of the earth and the solar system. Good PAP achievement indicates that most students are able to meet the established completion criteria (KKTP), namely a score of ≥ 71 on the post-test. This good achievement is supported by 66.67% of students completing, 80% of students completing the material of ecology and biodiversity, and 76.67% of students completing the material of the earth and the solar system.

The achievement of student learning completion that is more than half of the student sample indicates that the e-module based on Bahau local wisdom is effective in improving student

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learning outcomes increasing student understanding and engagement with the subject matter through independent learning and active participation. The effectiveness of the learning outcomes demonstrated that the application of learning technology in the Bahau local wisdom-based inquiry e-module can contribute to more effective learning.

The effectiveness of the local wisdom-based e-module's scientific literacy achievement was also demonstrated by students' achievement of a moderate n-gain score, with an n-gain score of 0.50. Meeting the KKTP criteria resulted in a student completion score of 87%. The satisfactory achievement of scientific literacy is demonstrated by students' ability to meet three aspects of scientific literacy: explaining existing scientific phenomena by connecting their existing concepts to explain observed natural phenomena; evaluating and designing scientific investigations; and developing a scientifically sound problem-solving plan. Furthermore, students' ability to interpret data and evidence scientifically also improved, as students were presented with data and then provided scientific answers based on the data.

The Bahau local wisdom-based inquiry e-module is considered effective in helping improve scientific literacy due to its presentation, which considers the steps of inquiry learning and the connection of learning content to students' lifestyles through the local wisdom presented. The material is structured based on a guided inquiry approach in accordance with the steps of scientific inquiry, such as formulating problems, conducting experiments, and drawing conclusions from real-world phenomena. This makes learning more meaningful, applicable, and encourages higher-order thinking in improving students' scientific literacy.

The results of this study also align with research conducted by Saefullah et al. (2017), which found that the guided inquiry learning model can improve students' scientific literacy skills by integrating the application of local wisdom, enabling students to understand the concept of sustainability, understand their relationship with nature, learn about conservation, and think skillfully in creating more effective solutions to address natural phenomena. With successful validation, practicality, and effectiveness, this module can be recommended for wider use in schools with local cultural potential as part of contextual learning. In addition to strengthening cultural identity, this approach can also improve the quality of science learning in elementary and secondary schools. The dissemination phase involves the dissemination of the e-module to teacher groups in Long Pahangai District and the Science MGMP for use in teaching.

Conclusion

E-Modin with local wisdom is effective in improving students' learning outcomes and scientific literacy. Its presentation pays attention to local culture and scientific approaches through guided inquiry. This module has proven to be easy to validate, practical, and effective in facilitating independent learning and supporting improvements in students' learning outcomes and scientific literacy. Support from quantitative and qualitative evidence suggests that this model is feasible to be widely applied in similar contexts. For further research and development by paying attention to local culture in order to achieve learning that pays attention to appropriate student characteristics.

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