

DEVELOPMENT OF AN IT INTEGRATED BIOLOGY MODULE BASED ON PAPUAN LOCAL WISDOM ON BIODIVERSITY MATERIAL FOR GRADE X SENIOR HIGH SCHOOL STUDENTS

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Abstract

Learning becomes meaningful when it is carried out in a contextual manner. But, Biology education in Papua tends to follow national standards, as the textbooks used in schools are provided by the government which does not include elements of Papuan local wisdom. In addition, information technology is essential for developing 21st-century learning skills. This biology module based on Papuan local wisdom and integrated with IT can serve as an option in the learning process. This study aims to develop a biology module based on Papuan local wisdom that is integrated with IT. This study employs a research and development (R&D) methodology using the 4D (four-D) model, which includes the define, design, development, and disseminate stages. The developed product is a biology module containing material on biodiversity linked to Papuan local wisdom and supported by the integration of information technology in the form of educational images and videos accessible via QR codes. Product validity was assessed by two validators to evaluate content, language, and presentation. Meanwhile, the practicality and effectiveness test was conducted on 14 tenth-grade science students at Meepago State High School. The test results showed that the developed modules met the criteria for very validity, very practicality, very effective.

Keywords: *Module, Local Wisdom, Technology informasi, Validity, Practicality, Effectiveness.*

INTRODUCTION

Biology education in high school plays a crucial role in shaping students' understanding of the components of life, biological processes, and the interactions between living organisms and their environment. One of the foundational topics in biology education is biodiversity, as it is directly related to ecosystem conservation, the utilization of natural resources, the development of scientific attitudes, and environmental awareness. However, the teaching of biodiversity often focuses solely on theory and general examples from other regions, thereby failing to provide meaningful learning experiences for students. Papua possesses exceptionally high biodiversity and ranks among the highest in both Indonesia and the world. Papua is home to tropical rainforest, mangrove, and mountain ecosystems that serve as habitats for various endemic flora and fauna, such as birds of paradise, cassowaries, kangaroos, black orchids, and various traditional medicinal plants. Papua is home to 15,000–20,000 plant species (55% endemic), 602 bird species (52% endemic), 125 mammal species (58% endemic), and 223 reptile species (35% endemic) (Marshall & Beehler, 2012). This wealth of natural resources should serve as a highly potential learning resource, particularly in biology education focusing on biodiversity. According to Hafid et al. (2025), the concept of Papuan local wisdom can be applied in learning materials, encompassing social values and norms, traditional knowledge, customs, language, folklore, and culture. In fact, learning in schools is not contextual. According to Tilaar (2006), the education system in Indonesia tends to be oriented toward a uniform and centralized. national curriculum. Consequently, teachers focus more on achieving national standards, so the integration of local wisdom is rarely implemented. In addition to pursuing national standard targets, learning that is not based on local wisdom is also caused by teachers' lack of understanding of the potential of local wisdom, leading to learning that tends to be theoretical and lacking in local cultural content. According to Mystakidis (2021), Its achievement is verified

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through knowledge application in authentic contexts. Advances in information technology (IT) offer significant opportunities to encourage students to learn independently. The use of IT in developing modules allows for the presentation of material that is more interactive, engaging, and easily accessible. IT-integrated modules can facilitate students in conducting broader explorations of Papua's biodiversity. According to Basiilota-Gomez-Pabloz et al (2022) "Digital competence has gained a strong prominence in the educational context, being one of the key competencies that teachers must master in today's society."

Understanding biodiversity is not limited to classroom learning but can also be done independently through the provision of biology modules that are easy for students to understand and use, wherever and whenever they choose. An alternative solution for students to learn independently is by developing modules (Nisa et al, 2022). The development of modules based on Papuan local wisdom has been carried out by Batigin (2024) under the title "Development of E- modules Based on Papuan Local Wisdom on the Topic of Interactions Between Living Organisms and Their Environment for 7th Grade Junior High School/MTS Students," demonstrating that the development of modules based on local wisdom and integrated with IT is capable of producing highly suitable modules. To address the issues mentioned above, a Biology module based on Papuan local wisdom and integrated with IT has been developed. A validity test was conducted by two validators to assess content, language, and presentation, while a practicality test was conducted with 10th-grade (X) Science students at Meepago State High School. The development of modules based on local wisdom and integrated with IT is crucial as an alternative teaching resource amid the scarcity of IT-based and contextual teaching materials in Papua, and it also supports the implementation of the Merdeka Curriculum, which demands meaningful learning, differentiation, and the Pancasila learner profile. By integrating IT, this module also aligns with 21st-century learning needs that emphasize digital literacy, critical thinking, and problem-solving skills.

METHOD

This study uses R&D (Research and Development). The development of this module uses the 4D (Four D) development model. The 4D model consists of four main stages, namely: define, design, develop, and disseminate. The research subjects in this study were 14 tenth-grade science students who were used to test the module's practicality. The practicality test was conducted via a questionnaire. Meanwhile, the module's validity was assessed by two experts. The validity test was conducted using a questionnaire to assess the content, language, and presentation of the developed module. The module was considered valid and practical if the results from the validators and student responses reached 61%. The formula for calculating validity is as follows (Arikunto, 2013):

$$V = \frac{\sum x}{n} \times 100\%$$

Explanation:

V = Validity
 $\sum x$ = Score obtained
n = Maximum score

Validity analysis was conducted by summing the total scores of each expert, combining them, and calculating the average to obtain the final validity test score. The results of the combined analysis were then compared with the validity category Table 1.

Table 1. Validity Category

No	Percentage (%)	Category
1	81-100	Highly Valid
2	61-80	Valid
3	41-60	Quite Valid
4	21-40	Less Valid
5	0-20	Invalid

Meanwhile, to calculate practicality, use the following formula (Sugiyono, 2019):

$$P = \frac{\sum x}{n} \times 100\%$$

Explanation:

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P = Practicality
 $\sum x$ = Score obtained
n = Maximum score

The practicality analysis of the module was conducted by summing all scores, combining them, and calculating the average to obtain the final practicality test score. The combined analysis results were then matched with the practicality category in Table 2.

Table 2. Practicality Category

No	Percentage (%)	Category
1	81-100	Highly Practicality
2	61-80	Practicality
3	41-60	Quite Practicality
4	21-40	Less Practicality
5	0-20	Unpracticality

Meanwhile, the effectiveness assessment of the module was determined by examining students learning mastery. Learning mastery was measured using an evaluating test consisting of 20 questions. The guidelines for categorizing learning mastery outcomes are presented in the following table 3.

Table 3. Mastery Category

No	Interval	Category
1	81-100	Very good
2	70-80	Good
3	60-69	Fair
4	45-59	Poor
5	< 45	Very poor

Source: Arikunto (2013)

RESULTS AND DISCUSSION

Result

The product developed in this study is a Biology module based on Papuan local wisdom and integrated with IT, designed for the 10th-grade high school curriculum on biodiversity. The module was developed by integrating biological concepts with Papuan local wisdom, such as the unique flora and fauna of Papua, the indigenous communities' culture of environmental conservation, and the wise use of natural resources. Additionally, the module utilizes information technology in the form of QR codes to access educational videos and image-matching games, making the learning process more engaging and interactive. The developed module consists of an introduction, learning outcomes, learning objectives, learning materials, in-depth material, practice questions, evaluation, a glossary, and a bibliography. The module's layout is designed to be systematic and engaging, with the use of relevant images to help students understand the material in a more contextual manner. The module was validated by two experts to determine the suitability of the developed module. The aspects evaluated included content suitability, language, presentation, integration of Papuan local wisdom, and the use of information technology. Following validation, revisions were made based on the suggestions and feedback from the validators. The revisions made during the development of this module can be seen in Figure 1.

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Figure 1. (a) Initial Display (before revision) Front Cover (b) Back Cover and (c) Page Background (Source: Epit H. Magai).



Figure 2. (a) Front cover (after revision). (b) Back cover, and (c) Page background. (Source: Epit H. Magai)

Revisions made during the development of this module include improving the front and back covers to reflect the local wisdom of Papua, redesigning the background to make it less plain and more appealing to students, making the language more communicative so that students can understand it easily, correcting typos and grammatical errors, and highlighting examples of Papua's local wisdom integrated into the module. The results of the module validation can be seen in table 4.

Table 4. Validity Category

Statement	Validity Level		Total	%	Category
	Validator 1	Validator 2			
1	5	5	10	100	Very valid
2	4	4	8	80	Valid
3	4	4	8	80	Valid
4	4	4	8	80	Valid
5	4	4	8	80	Valid
6	4	4	8	80	Valid
7	4	5	9	90	Very valid
8	4	4	8	80	Valid
9	4	4	8	80	Valid
10	4	4	8	80	Valid
11	5	4	9	90	Very valid
12	4	4	8	80	Valid
13	4	4	8	80	Valid
14	4	5	9	90	Very valid
15	4	4	8	80	Valid
16	4	5	9	90	Very valid
17	5	4	9	90	Very valid
18	4	5	9	90	Very valid
Total	75	77	152		
%	83.33	85.6		84.44	Highly valid
Average				4.22	

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Based on the data in the table above, the module evaluation by Validator I is divided into two categories: valid and highly valid. The total score for the highly valid category is 3. Meanwhile, the total score for the valid category is 15. When accumulated, Validator I's total score is 75, with an average percentage of 83.33% in the highly valid category. Validator II's module evaluation is divided into two categories: valid and highly valid. The total score for the valid category is 5, while the highly valid category is 13. When accumulated, Validator II's total evaluation score is 77, with an average percentage of 85.56% in the highly valid category. Based on the data in Table 3, the final evaluation score by the validator for the Papua local wisdom-based biology module integrated with IT on the 10th-grade biodiversity material developed has a total evaluation score of 152 with a percentage of 84.44% meeting the "highly valid" criterion. The practicality of the module was assessed through a questionnaire completed by 10th-grade science students after using the module in the learning process. The results regarding the module's practicality are presented in table 5.

Table 5. Practicality Category

No	Student	Score	%	Category
1	Student 1	59	98.33	Very practical
2	Student 2	59	98.33	Very practical
3	Student 3	60	100	Very practical
4	Student 4	57	95	Very practical
5	Student 5	60	100	Very practical
6	Student 6	60	100	Very practical
7	Student 7	52	86.67	Very practical
8	Student 8	60	100	Very practical
9	Student 9	60	100	Very practical
10	Student 10	60	100	Very practical
11	Student 11	51	85	Very practical
12	Student 12	54	90	Very practical
13	Student 13	52	86.67	Very practical
14	Student 14	47	78.33	Practical
Total		791	1,318.33	
Average			94.17	Very practical

After students have studied all the learning materials, they are asked to complete an assessment to evaluate the effectiveness of the module. The assessment consists of 15 multiple-choice questions and 5 essay questions. The minimum passing grade for Biology at Meepago State High School is 70. The results of the assessment for 10th-grade science students can be seen in Table 6.

Table 6. Practicality Category

No	Student	Score	MMC	Category
1	Student 1	80	70	Mastery
2	Student 2	75	70	Mastery
3	Student 3	80	70	Mastery
4	Student 4	60	70	Non-mastery
5	Student 5	70	70	Mastery
6	Student 6	100	70	Mastery
7	Student 7	80	70	Mastery
8	Student 8	75	70	Mastery
9	Student 9	80	70	Mastery
10	Student 10	80	70	Mastery
11	Student 11	75	70	Mastery
12	Student 12	75	70	Mastery
13	Student 13	80	70	Mastery
14	Student 14	80	70	Mastery
Total		1090		
		77,86		
Average		92,86		Mastery

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Based on the data above, in the 10th-grade science class, which consists of 14 students, 13 students met the passing criteria, while 1 student did not meet the criteria, scoring 60. The pass rate was 92.86% very effective criteria.

Discussion

This study aims to produce a biology module based on Papuan local wisdom and integrated with IT on the topic of biodiversity. The development process was conducted using the Research and Development (R&D) method. The development model used was the 4D model (Define, Design, Develop, and Disseminate). This study was limited to the "Develop" stage. In the first stage (define), a literature review, curriculum analysis, and content analysis were conducted. The curriculum analysis was performed to determine the alignment between educational objectives and instructional materials, methods, and assessment. The content analysis was conducted to identify essential, relevant material appropriate to students' ability levels, and beneficial in real-life contexts (Sanjaya, 2013). Based on the results of the literature review, curriculum analysis, and content analysis, the following conclusions can be drawn: a. The textbooks and modules used in nearly all schools in Papua are those provided by the government and other relevant textbooks on biodiversity. These books do not include examples based on Papuan local wisdom. Furthermore, they fail to connect the material to real-life situations in Papua. Additionally, there is a lack of IT-integrated modules to strengthen digital literacy. Consequently, learning becomes decontextualized because instruction follows the existing textbooks. b. Analysis results indicate that biodiversity curriculum instruction consists of the definition of biodiversity, levels of biodiversity (genetic, species, and ecosystem diversity), types of ecosystems, the distribution of flora and fauna in Indonesia, threats to and conservation efforts for biodiversity, and the benefits of biodiversity.

These findings do not align with Sentosari's (2016) perspective, which states that contextual learning enhances conceptual understanding because students learn from real-world experiences. Contextual learning enables students to understand the relevance of scientific concepts in daily life (Gilbert, 2006). On the other hand, the integration of information technology into the module addresses the demands of 21st-century learning, which emphasizes digital literacy. The use of media such as QR codes, Google Forms, and instructional videos provides a more varied and engaging learning experience. According to Trilling & Fadel (2009), 21st-century learning must integrate technology to enhance students' critical thinking skills, creativity, and digital literacy.

The second stage (design) is carried out during the module design phase. The module is structured with the following components: cover, title page, table of contents, glossary, introduction (consisting of the module's identity and a brief description of the material), instructions for using the module, competencies (consisting of core competencies and indicators), concept map, learning sections (I, II, and III), in-depth material (consisting of links and QR codes for educational videos), summary, practice questions (5 multiple-choice questions and 5 essay questions), links and QR codes for completing the practice questions, answer key, grading instructions, self-assessment, evaluation questions, and bibliography. According to Mulder (2017), modules must be organized systematically to facilitate learner-centered learning. The development of this module integrates Papuan local wisdom, including: the custom of chewing betel nut commonly practiced by Papuan communities, the use of betel nut to resolve conflicts, dowry, and several other traditional ceremonies, varieties of sweet potatoes as the staple food of the Papuan highland communities, varieties of sago as the staple food of the Papuan coastal communities, red fruit frequently consumed by Papuan communities as a highly nutritious food, and the implementation of traditional sasi regulations the closure of marine or forest areas to allow time for the regeneration of marine and forest biodiversity. As well as various other examples rooted in Papuan local wisdom. This module integrates several educational videos to deepen learning and practice exercises, along with digital-based assessments to strengthen digital literacy. The instruments used in this study include an expert validation instrument and a student response questionnaire. Following this, the module was validated by validators.

Validity criteria were established based on the validators' assessments. In this study, validation was conducted by two experts to evaluate content, language, and presentation. The validators reviewed and analyzed the developed materials, providing feedback on whether the module was valid or required revisions. According to Plomp and Nieveen (2013), expert validation is a crucial step in ensuring that the developed product aligns with learning objectives and is suitable for use. Below is a breakdown of the experts' evaluations of the Papua-based local wisdom biology module integrated with IT, focusing on content, language, and presentation. The first validator gave a total score of 75, with an average percentage score of 83.33%. Meanwhile, the second expert gave a total score of 77, with an average percentage score of 85.6%. The average of the validity test results is 84.44%. According to Indah *et al.* (2014) as cited in Yunendar (2016), a module is considered valid if it is capable of assessing what it is intended to assess. In this study, the biology module that has been developed has been validated by the validators designated

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for this purpose. These results indicate that the module meets the criteria for suitability as instructional material and can be used in biology instruction on the topic of biodiversity. The high level of the module's validity indicates that the product was developed systematically and in accordance with the principles of good instructional material design. The module was designed by integrating Papuan local wisdom with information technology, resulting in instructional material that is not only academically relevant but also contextually appropriate and aligned with contemporary developments. This aligns with Sugiyono's (2016) view that the validity of a product indicates the extent to which it achieves the established learning objectives. According to Pallennari and Daud (2019), product validity indicates that the developed instructional materials developed meets the criteria for suitability and can therefore be used in the learning process.

A product classified as highly valid indicates that the content, presentation, and media design align with the learning objectives and the needs of the learners. Several factors contributing to the "highly valid" rating include: First, the module in this study integrates two approaches simultaneously local wisdom and information technology there by providing added value compared to studies that use only a single approach. This integration makes the material more contextual and interactive, leading validators to deem it more suitable. Second, the module was designed with a systematic and comprehensive structure, encompassing learning objectives, content, and assessment. This allows the module to be used independently by students. According to Daryanto (2013), instructional materials that are systematically and comprehensively organized are easier to understand and of higher quality. Third, the use of communicative language and an attractive visual design also contribute to the module's high validity score. The module is designed to be easily understood by students, thereby avoiding difficulties in the learning process. This aligns with Arsyad's (2015) view that clarity of language and an engaging visual presentation are crucial components of instructional materials. Based on the data above, it can be concluded that the IT-integrated biology module based on Papuan local wisdom for 10th-grade high school biodiversity content meets the criteria for high validity in terms of content, language, and presentation.

The practicality of this study was assessed through a questionnaire administered to 10th-grade science students. The practicality test was conducted to determine whether the module was easy to use, engaging, and how well it could be implemented. The total score from the 10th-grade science students was 791, with an average percentage of 94.17%, meeting the criteria for "very practical." According to Musriadi (2016) as cited in Yunendar (2016), a module is considered practical if it can be used by anyone with relative ease. These results indicate that the module meets the criteria as instructional material and can be utilized in biology instruction on the topic of biodiversity. The high level of practicality of this module indicates that the developed product aligns with the characteristics of the students. The module was designed with a focus on ease of use, clarity of instructions, and comprehensibility of the material, ensuring that students do not encounter difficulties when using it independently. This aligns with Sugiyono's (2019) view that the practicality of a development product is demonstrated by its ease of use in real-world conditions. Additionally, the use of a Papua-based local wisdom approach in the module significantly contributes to its practicality. The presented material becomes more relevant to students' lives because it is directly related to their surrounding environment. This makes it easier for students to understand the material being studied. According to Trianto (2010), contextual learning is easier for students to grasp because the material is linked to real-life experiences.

The integration of information technology into the module also enhances its practicality. The use of QR codes and digital media allows students to access the material independently and flexibly. This provides a more engaging and less monotonous learning experience. According to Munir (2017), the use of technology in learning can improve the efficiency and flexibility of the learning process. Several factors contributing to the high level of practicality of this module include: First, the module in this study combines local wisdom and information technology simultaneously, thereby providing a more comprehensive and engaging learning experience for students. Second, the module is designed with a systematic structure and clear usage instructions, making it easier for students to follow the learning flow. This aligns with Daryanto's (2013) view that effective instructional materials must be user- friendly and guide students in independent learning. Meanwhile, Nurhayati, Hadis, and Faisal (2018) state that developed learning modules must meet practicality criteria to be easily used in the learning process and help students understand the material more independently and purposefully. Third, an attractive module design and the use of communicative language also serve as factors that enhance practicality. Students are more inclined to use modules with good design and that are easy to understand. This is supported by Arsyad's (2015) assertion that visually appealing designs can boost students' learning motivation. Based on the practicality test conducted with biology teachers at Meepago State High School as 10th-grade students in the Science classes at Meepago State High School, it can be concluded that the IT-integrated biology module based on Papuan local wisdom for 10th-grade high school

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biodiversity material is highly practical in terms of appeal, time efficiency, appeal, feasibility, and benefits.. The effectiveness of the IT-integrated biology module based on Papuan local wisdom for the 10th-grade biodiversity curriculum is assessed by examining student learning achievement. Achievement is measured using an evaluation test consisting of 20 questions. The results of the learning assessment for the 10th-grade science class, consisting of 14 students, showed that 13 students met the mastery criteria and 1 student did not meet the criteria, scoring 60. The percentage of students meeting the mastery criteria was 92.86%, with an average score of 77.86. According to Andayani (2015) as cited in Yunendar (2016), effectiveness can be observed if the learning materials increase students' interest and motivation, such that after the lesson, students become more motivated to study harder and achieve better learning outcomes. Meanwhile, according to Bahri *et al.* (2021), the effectiveness of a learning module is demonstrated by an improvement in students' learning outcomes after using the developed instructional materials. A product is considered effective if it helps students achieve learning objectives and master the material in a classroom setting. The results above indicate that the module meets the criteria for instructional materials and can be used in biology lessons on the topic of biodiversity.

Based on the analysis results, the majority of students achieved scores above the minimum passing score set by the school. This indicates that the developed modules are effective in helping students understand the learning material. This high level of learning achievement demonstrates that the use of the modules optimally supports the attainment of learning objectives. This effectiveness is closely tied to the characteristics of the modules, which were designed contextually through the integration of Papua's local wisdom. The material presented is not merely theoretical but is linked to real-world conditions in the students' environment, such as Papua's unique biodiversity and local conservation practices like the traditional sasi system. This makes it easier for students to grasp the concepts being studied. According to Trianto (2010), learning that connects content to real-life contexts can improve student learning outcomes by providing meaningful learning experiences. Additionally, the integration of information technology within the modules contributes to the effectiveness of learning. The use of QR codes allows students to access supplementary learning resources that reinforce their understanding of the material. According to Munir (2017), the use of technology in learning can increase effectiveness because it provides a variety of learning resources and enriches students' learning experiences.

Research conducted by Lestari, Siregar, and Nainggolan (2019) shows that environment-based learning modules effectively improve student learning outcomes, as evidenced by higher post-test scores and the achievement of the minimum passing score. Meanwhile, research conducted by Rifkanita, Hala, and Daud (2023) found that the use of corporate flip PDF-based e-modules was proven to enhance learning effectiveness, as evidenced by an increase in students' learning mastery. Additionally, Ahmad, Daud, and Palennari (2024) also explained that interactive e-modules based on the I-Spring application can help students achieve learning mastery. Similarly, in Yunendar's (2016) study, it was found that smartphone-based (Android) instructional materials significantly improved students' learning achievement. Another study by Afdalia, Arsyad, and Arafah (2020) showed that modules developed based on local wisdom are effective in improving students' learning outcomes, with a learning achievement rate of 76% in the development of these modules. Another study conducted by Atmaja, Murtadho, and Akbar (2021) showed that teaching materials based on local wisdom can improve student learning achievement because the material is easier to understand, enabling students to achieve scores above the minimum passing grade after using the modules. This reinforces the notion that well-designed instructional materials can improve learning outcomes. However, there are differences in the approaches used. This study emphasizes the simultaneous integration of Papuan local wisdom and information technology, which is an advantage over some previous studies that focused on only one approach. This integration has a positive impact not only on cognitive aspects but also on students' contextual understanding of the local environment and culture. Nevertheless, the measurement of effectiveness in this study is still limited to final evaluation results without comparing them to students' initial abilities through a pretest. Based on the results of the mastery test using the IT-integrated, Papua-based local wisdom biology module on biodiversity material for 10th-grade high school students at Meepago State High School, it can be concluded that the IT-integrated, Papua-based local wisdom biology module on biodiversity is effective.

CONCLUSION

Based on the results of the validation, practicality assessment, and effectiveness measurement, it can be concluded that the IT-integrated Biology module developed based on Papuan local wisdom meets high criteria for validity, practicality, and effectiveness, making it suitable for use as teaching material on biodiversity for 10th-grade high school students. Suggestions from validators and students can serve as valuable input that should be considered

to create an even better module. Hopefully, teachers and students can use this module as an alternative teaching material.

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DEVELOPMENT OF AN IT INTEGRATED BIOLOGY MODULE BASED ON PAPUAN LOCAL WISDOM ON BIODIVERSITY MATERIAL FOR GRADE X SENIOR HIGH SCHOOL STUDENTS

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