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Development of E-Modules Based on Batak Toba Local Wisdom on Biodiversity to Improve Learning Outcomes of Grade X Students

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ABSTRAK

Penelitian ini bertujuan untuk mengembangkan E-Modul berbasis kearifan lokal Batak Toba pada materi keanekaragaman hayati, serta mengetahui kelayakan, respon peserta didik, dan pengaruhnya terhadap hasil belajar siswa kelas X SMA Negeri 2 Pematangsiantar. Penelitian ini menggunakan metode Research and Development (R&D) dengan model pengembangan ADDIE (Analysis, Design, Development, Implementation, Evaluation) yang dipadukan dengan desain Pretest-Posttest Control Group Design. Sampel penelitian ditentukan melalui teknik purposive sampling, yaitu kelas X-4 sebagai kelas eksperimen dan kelas X-10 sebagai kelas kontrol, masing-masing berjumlah 36 siswa. Data dikumpulkan melalui angket validasi ahli, angket respon peserta didik, serta tes hasil belajar berbentuk soal pilihan ganda, kemudian dianalisis secara deskriptif dan melalui uji independent sample t-test. Hasil penelitian menunjukkan bahwa E-Modul yang dikembangkan dinyatakan sangat layak berdasarkan penilaian delapan validator pada aspek isi materi, penyajian, desain, dan bahasa. Peserta didik juga memberikan respon yang sangat positif terhadap penggunaan E-Modul. Rata-rata nilai posttest kelas eksperimen meningkat dari 48,0% menjadi 81,3%, lebih tinggi dibandingkan kelas kontrol yang meningkat dari 26,3% menjadi 68,1%. Hasil uji independent sample t-test menunjukkan nilai signifikansi sebesar 0,024 (< 0,05), yang berarti terdapat pengaruh signifikan penggunaan E-Modul terhadap hasil belajar siswa. Dengan demikian, E-Modul berbasis kearifan lokal Batak Toba layak digunakan sebagai bahan ajar alternatif yang mampu meningkatkan hasil belajar peserta didik pada materi keanekaragaman hayati.

ABSTRACT

This study aimed to develop an E-Module based on Batak Toba local wisdom on biodiversity materials, and to determine its feasibility, students' responses, and its effect on the learning outcomes of tenth-grade students at SMA Negeri 2 Pematangsiantar. This study used the Research and Development (R&D) method with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) combined with a Pretest-Posttest Control Group Design. The sample was determined through purposive sampling, namely class X-4 as the experimental class and class X-10 as the control class, each consisting of 36 students. Data were collected through expert validation questionnaires, student response questionnaires, and multiple-choice learning outcome tests, then analyzed descriptively and through an independent sample t-test. The results showed that the developed E-Module was categorized as very feasible based on the assessment of eight validators covering content, presentation, design, and language aspects. Students also gave a very positive response to the use of the E-Module. The average posttest score of the experimental class increased from 48.0% to 81.3%, higher than the control class which increased from 26.3% to 68.1%. The independent sample t-test showed a significant value of 0.024 (< 0.05), indicating a significant effect of the E-Module on students' learning outcomes. Thus, the Toba Batak local wisdom-based E-Module is feasible to be used as an alternative teaching material that can improve students' learning outcomes on biodiversity material.

1. INTRODUCTION

Education is a conscious and planned effort to create a learning environment and process that allows students to actively develop their potential. Within the framework of the independent curriculum, education places significant emphasis on enriching learning experiences that instill cultural values from an early age. The use of

local wisdom makes learning more contextual and relevant to everyday life, enabling students to learn not only theoretical knowledge but also practice it through concrete examples from their surroundings.

The development of information and communication technology has brought enormous changes to the progress of the world of education. Along with these developments, learning methods have also developed more, both personal learning methods and the learning process. The form of the development of information technology that is applied in the world of education is e-learning. Learning by using web or electronic learning (e-learning) has unlimited space and time to provide an effective learning whenever we want to access it if we have computer, tablet, and mobile phone that connected to the internet. As well as student-teacher interaction become easier in real time(Silalahi, 2020).

Observations with biology teachers at SMA Negeri 2 Pematangsiantar show that the classroom learning process still tends to be monotonous due to the lack of varied learning media and the dominance of lecture methods. This condition impacts student learning outcomes. Mid-term exam (UTS) scores for grade X Biology at SMA Negeri 2 Pematangsiantar for the 2025/2026 academic year in 11 classes with a total of 396 students show that only 170 students (42.92%) achieved the minimum completeness criteria (KKM), while 226 students (57.08%) had not yet completed the test. In addition, the use of technology in developing teaching materials based on Batak Toba local wisdom has never been implemented at the school, even though the integration of technology with local wisdom can provide a more contextual and meaningful learning experience for students.

The local wisdom of the Toba Batak people is a potential resource that can be integrated into biology learning, particularly in biodiversity. One form of local wisdom that can be utilized is traditional Toba Batak culinary delights, such as dekke naniura, ikan mas arsik, natinombur, napinadar, and dali ni horbo, all of which reflect the utilization of biodiversity in the community's environment (Pakpahan et al., 2020). Research related to the development of teaching materials based on the local wisdom of the Toba Batak people also shows that the majority of students require relevant and engaging additional teaching materials and agree that the development of local wisdom-based e-modules is a more effective learning alternative. (Lamtiur et al., 2022) Along with the rapid development of information technology in the era of the industrial revolution 4.0, the need for teaching materials is no longer limited to printed forms. Currently, interactive teaching materials are needed, which not only present text, but also combine visual elements, images, audio, and other digital media to enable students to learn independently through electronic devices, one of which is through the development of e-modules (electronic modules) (Ningsih & Fuadiah, 2022). Several studies have developed ethnoscience-based e-modules, one of which was conducted by (Riza, et al., 2020), who developed a chemistry module oriented towards local wisdom with the topic of acid and base solutions, and obtained a feasibility score of 85.3% and 87.3%, which is included in the very good category. (Hidayati, 2025). A flipbook is an e-book-style learning resource with a digital electronic format that is easily accessible via the internet (Apriliyani & Mulyatna, 2021). (Biologi & Hayati, 2024) According to Lufri et al. (2020: 26), biology is a discipline that requires understanding, application, analysis, synthesis, and evaluation—or higher-order thinking. An e-module is one type of medium that can be used in biology instruction to facilitate these processes. (Dewantari et al., 2026) Research by Kamsinah et al. (2020) indicates that critical thinking skills in science learning remain very low. One contributing factor is that learning activities fail to provide opportunities for students to develop these skills. One method to enhance students' critical thinking skills is through the use of SSI-based (Socio-Scientific Issues) e-modules. A module is a teaching resource containing learning material that students can use independently. There are two common types of modules used in instruction: printed modules and electronic modules (e-modules). (Oktavia & Sitti, 2025) In line with this, the use of e-modules as digital learning media has become increasingly relevant amidst the growing need for independent, technology-based learning. E-modules offer advantages over printed modules, such as interactivity, ease of navigation, and the integration of multimedia elements—including videos, animations, and automated quizzes (Cynthia et al., 2023; Fujiarti et al., 2024; Risnawati et al., 2025). (Hadi et al., 2022) The development of modules based on science process skills still needs to be developed to hone the science process skills. (Lema & Dewi, 2023) According to Basaroh et al. (2020: 31) , e-modules are a suitable technology for student learning, where e-modules are combined with interactive animations, pictures and videos that will make students more enthusiastic about learning. Through the development of the biodiversity e-module in the Kelimutu National Park area, it is able to improve student learning outcomes on biodiversity material. Based on the description above, it is necessary to conduct research to analyze the biodiversity in the Kelimutu Ende National Park area as material in the development of biodiversity e-modules in the Kelimutu Ende National Park area which can improve student learning outcomes on biodiversity material. (Izzah, 2025). Jamaludin et al. (2020) state that the use of media in the learning process remains limited. The use of media plays a crucial role in learning activities by enhancing students' critical thinking skills. One way to strengthen students' critical thinking abilities is through the use of e-modules. An e-module is a type of learning material featuring relevant, concise, and specific content, with characteristics that support independent learning. (Erninda et al., 2021) Based on the research conducted, it is concluded that the media developed falls into the "very good" category; similarly, the research by Komala Dewi (2019) on a biology module based on West Lampung local wisdom for Grade X (Senior High School/Islamic Senior High School level) was also classified as "very

interesting." (Adinugraha, 2020) Modules offer advantages over other teaching materials because students can study independently without a teacher present at their own pace, supported by simple language and accompanied by practice exercises. (Li1, 2023) Local wisdom and culture are legacies from our ancestors; local wisdom must be developed and preserved to prevent it from disappearing. According to Uju, Bhuja, and Boro (2019), local wisdom represents an ancestral legacy regarding life values that are integrated into religion, culture, and customs.

Based on the description, this study aims to develop an E-Module based on Batak Toba local wisdom on biodiversity material to help students understand the material more contextually and improve their learning outcomes. Specifically, this study aims to determine: (1) the feasibility of an E-Module based on Batak Toba local wisdom on biodiversity material for class X at SMA Negeri 2 Pematangsiantar; (2) students' responses to the E-Module; and (3) the effect of using the E-Module on students' learning outcomes on biodiversity material.

The lecturer responses indicated a 91% rating in the "very practical" category for the e-module, while students similarly rated it at 89% in the same category. The control group showed a low N-gain value of 0.15, whereas the experimental group demonstrated a high N-gain value of 0.74. The e-modules, which employ project-based learning, effectively enhance students' psychomotor skills and engagement, aligning the curriculum with industry demands. Technology integration in the classroom paves the way for further advancements in fashion education and other fields. These results indicate that the e-module is not only valid and practical but also effective in enhancing communication and creativity skills, thus supporting the development of 21st-century competencies.

2. METHOD

This study employed the Research and Development (R&D) method, a research method used to generate new product designs while simultaneously testing their effectiveness The development model used was ADDIE (Analysis, Design, Development, Implementation, Evaluation) because it is systematic and interactive, where evaluation results at each stage can be used to improve the previous stage

2.1. Research Design

To test the effect of e-modules on learning outcomes, this study used a pretest-posttest control group design. The experimental and control classes were determined purposively, and both classes were given a pretest. The experimental class received treatment in the form of learning using e-modules, while the control class underwent learning without e-modules. After the treatment, both classes were given a posttest to see the difference in learning outcomes.

Table 1. Research Design Pretest-Posttest Control Group Design

Class	Pretest	Treatment	Posttest
Experiment	O1	X	O2
Control	O3	-	O4

Description: O1 = pretest of experimental class; O3 = pretest of control class; X = treatment (use of E-Module); O2 = posttest of experimental class; O4 = posttest of control class.

2.2. Location, Population, and Research Sample

The research was conducted at SMA Negeri 2 Pematangsiantar from May to August of the 2026/2027 academic year. The research population was all grade X students of SMA Negeri 2 Pematangsiantar, consisting of 11 classes with a total of 396 students. The sample was determined by purposive sampling technique, namely class X-4 as the experimental class and class X-10 as the control class, each consisting of 36 students, so that the total sample was 72 students.

2.3. Research Variables

The independent variable in this study is the development of E-Modules based on local wisdom of the Toba Batak (X), while the dependent variable is student learning outcomes (Y).

2.4. Data Collection Instruments and Techniques

The research instruments used consisted of an expert validation questionnaire (biology lecturers and teachers) to assess the feasibility of the E-Module in terms of content/material, presentation, design, and language; a student response questionnaire using a Likert scale with 15 statement items to measure the practicality of the E-Module; and a learning outcome test in the form of 30 multiple-choice questions covering the cognitive domains C1-C4,

which had previously been tested for validity, reliability, discrimination power, and difficulty level using SPSS. The trial results showed that 20 of the 30 questions were declared valid with a Cronbach's Alpha reliability coefficient of 0.689.

2.5. Data Analysis Techniques

The e-Module feasibility data and student responses were analyzed quantitatively descriptively based on the percentage of assessment categories. Learning outcome data (pretest-posttest) were analyzed through prerequisite tests in the form of a normality test (Shapiro-Wilk) and a homogeneity test, followed by a hypothesis test using an independent sample t-test at a significance level of 0.05 to determine the difference in learning outcomes between the experimental and control classes.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. E-Module Eligibility

The e-module based on the local wisdom of the Toba Batak was developed using the ADDIE model, with the final product being a digital flipbook published via the FlipHTML5 website. The initial display of the e-module directly displays various types of typical Toba Batak foods (arsik, naniura, napinadar, ayam gota-gota, and lappet) as a context for the biodiversity material, thus making it easier for students to understand the relationship between the material and their local culture.

The e-module was validated by 8 validators, consisting of 6 biology lecturers and 2 biology teachers, on four assessment aspects, namely the suitability of the material content, presentation, design, and language. In the material content aspect, all indicators received an assessment in the range of "Very Good" and "Good", with an average of 75% of validators stating "Very Good". In the design aspect, the average percentage of "Very Good" scores was 64.06% and "Good" was 35.94%. In the language aspect, the highest indicator was in the "Very Good" category with an average of 58%, while the rest were in the "Good" category (41.67%). Overall, the e-module was declared to be in the category of very suitable for use as teaching materials.

3.1.2. Student Response

A student response questionnaire was distributed to all students in the experimental class after the e-module learning process was completed. It included 15 items related to the effectiveness, attractiveness, ease of use, and benefits of the e-module. The summary results showed that all student responses were in the "Very Good" and "Good" categories, with no answers falling into the "Sufficient," "Poor," or "Very Poor" categories. These findings indicate that students consistently responded positively to the use of the e-module in learning biodiversity.

3.1.3. Student Learning Outcomes

A comparison of pretest and posttest scores was conducted to determine changes in student learning outcomes after using the E-Module. In the control class, the average pretest score of 26.3% increased to 68.1% in the posttest (a 41.8% increase), but the posttest average was still below the Minimum Completion Criteria (KKM) (72). In the experimental class, the average pretest score of 48.0% increased to 81.3% in the posttest (a 48.8% increase), and this posttest average had exceeded the Minimum Completion Criteria (KKM). Data on the learning outcomes of both classes are presented in Table 2.

Table 2. Average Pretest and Posttest Scores of Experimental and Control Classes

Class	Pretest Average (%)	Posttest Average (%)	Increase (%)
Experiment	48.0	81.3	48.8
Control	26.3	68.1	41.8

Prior to hypothesis testing, prerequisite tests were conducted, including normality and homogeneity tests. The results of the Shapiro-Wilk normality test showed that all pretest and posttest data groups in both classes had significance values above 0.05 (ranging from 0.052 to 0.145), indicating that the data were normally distributed. The data were also deemed homogeneous, allowing for further analysis with an independent sample t-test.

Table 3. Results of the Independent Sample T-Test

t	df	Sig. (2-tailed)	Mean Difference
-2,310	70	0.024	-7,361

The results of the independent sample t-test showed a significance value (2-tailed) of 0.024, which is smaller than 0.05. Thus, H_0 is rejected and Ha is accepted, which means there is a significant difference in learning outcomes between the experimental class and the control class after using the E-Module based on Batak Toba local wisdom.

3.2. Discussion

Biodiversity material is often considered abstract and difficult for students to understand. An e-module based on Toba Batak local wisdom was developed as a teaching material that presents the material in a more engaging, contextual, and communicative way, using traditional Toba Batak foods as concrete examples of biodiversity in the students' environment.

In terms of feasibility, the results of this study align with the research of Li, Hastuti, and Cahyaningrum (2023) at SMAN 1 Sanggau Ledo, which addressed a similar topic and obtained validation results from material experts of 86.93% and media experts of 97.27% (very valid). The difference is that the previous study only involved two categories of validators, while this study involved eight validators from biology lecturers and teachers, thus the feasibility assessment results are considered more representative.

In terms of learning outcomes, the increase in the experimental class (48.0% to 81.3%) which far exceeded the control class (26.3% to 68.1%) is also in line with the findings in Sanggau Ledo which recorded an increase from 34.30 to 82.36 with the Wilcoxon Signed Ranks test (sig. 0.000 < 0.05). The difference is, that study only compared the before-after results in one group, while this study directly compared the experimental class and the control class, so the effect of the E-Module was proven to be statistically stronger.

The novelty of this research lies in the cultural context it explores: the local wisdom of the Toba Batak, combined with traditional foods such as arsik, naniura, napinadar, and lappet, demonstrating the rich biodiversity within them. This demonstrates that the local wisdom approach is flexible and adaptable to the richness of each region's culture without compromising its effectiveness as a learning medium.

4. CONCLUSION AND SUGGESTIONS

Based on the results of the research and discussion, it can be concluded that: (1) The E-Module based on the local wisdom of the Toba Batak on the material of biodiversity is declared very suitable for use as teaching material based on the aspects of content, presentation, language, and design; (2) students gave a very positive response to the E-Module in terms of appearance, ease of use, language, presentation of material, and the relevance of the material to the local wisdom of the Toba Batak; and (3) the use of the E-Module has a significant effect on improving student learning outcomes, which is indicated by the significance value of the independent sample t-test of 0.024 (<0.05).

Based on these results, it is suggested that teachers can apply E-Modules in class to motivate students to be more active in learning, students are expected to utilize E-Modules optimally to improve their learning achievements, and for further researchers it is suggested to develop similar research with more diverse variables and a wider sample scope.

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REFERENCES

Adinugraha, F. (2020). Modul keanekaragaman hayati dengan pendekatan kearifan lokal dan budaya di kabupaten purworejo. 5(1).

Biologi, J. P., & Hayati, K. (2024). Biogenerasi. 10(1).

Dewantari, N., Hendrastuti, Z. R., Ardiyani, L., Cahyani, R., & Rahmawati, N. (2026). Jurnal Penelitian Pendidikan IPA Pengembangan Modul Elektronik Berbasis SSI dengan Tema Keanekaragaman Hayati untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. 12(2), 662–669.

https://doi.org/10.29303/jppipa.v12i2.13962

Erninda, L., Studi, P., Biologi, P., Keguruan, F., Ilmu, D. A. N., & Riau, U. I. (2021). No Title.

Hadi, T., Atmaja, W., Pandia, E. S., & Manurung, N. (2022). Development of Biodiversity Practicum E-Module to improve Science Process Skills. 8(4), 1868–1873. https://doi.org/10.29303/jppipa.v8i4.1951

Hidayati, N. A. R. (2025). MELATIHKAN KETERAMPILAN LITERASI SAINS SISWA KELAS X SMA The Development of Flipbook on Biodiversity Material to Train Science Literacy Skills of 10 Th Grade Hight Schools Students Nurul Aini Riftaul Hidayati Sifak Indana Abstrak. 14(1), 32–44.

Izzah, N. (2025). PENGEMBANGAN E-MODUL BERBASIS KEARIFAN LOKAL PUGER. 2019.

Lamtiur, I. Y., Silaban, R., Sudrajat, A., Kimia, P., Medan, U. N., Kimia, M. P., & Medan, U. N. (2022). Analisis Kebutuhan terhadap Pengembangan E-Modul Laju Reaksi Berbasis Problem Based Learning dengan Konteks Kearifan Lokal Suku Batak Toba " Dekke Naniura " A Needs Analysis for Developing a Reaction Rate E-Module Based on Problem Based Learning in the Context of Batak Toba Local Wisdom " Dekke Naniura " Corresponding author : inkisimanjuntak@gmail.com. 178–184.

Lema, Y., & Dewi, N. K. (2023). Development of Biodiversity E-Module in Kelimutu National Park Area to Improve Learning Outcomes of High School Students. 12(1), 1–8.

Li1, L. (2023). Jurnal Pendidikan MIPA. 13, 1153–1161.

Oktavia, R., & Sitti, M. (2025). Jurnal Penelitian Pendidikan IPA Pengembangan Modul Elektronik Sains Berbasis STEM untuk Meningkatkan Keterampilan Komunikasi dan Kreativitas Siswa pada Materi Keanekaragaman Hayati. 11(9), 103–112. https://doi.org/10.29303/jppipa.v11i9.11981

Silalahi, M. V. (2020). Development of E-Modules Based on Exe-Learning on Topics of Reaction Rate Against Student Learning Outcomes Mechanical Engineering. International Journal of Education & Curriculum Application, 3(2), 114–120. http://journal.ummat.ac.id/index.php/IJECA